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Hazardous Pollutants in Class II Landfills

South Coast Air Quality Management District
El Monte, CA

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

HAZARDOUS POLLUTANTS IN CLASS II LANDFILLS

LABORATORY SERVICES BRANCH

TECHNICAL SERVICES DIVISION

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EXECUTIVE SUMMARY

The purpose of th~~is~~e study was to determine whether some contaminants, known to exist in landfills licensed to receive industrial wastes (Class I sites), were also found at landfills that receive ordinary trash (Class II sites). The District Board has adopted Rule 1150.1 which requires installation of controls for emissions from active landfill sites, and Rule 1150.2 which requires characterization and control of contaminants from inactive landfill sites in the South Coast Basin.

The District's Technical Services staff conducted a series of tests at 20 Class II sites beginning in 1984, and concluded that, although significant levels of vinyl chloride and benzene were found at many of those sites, the offsite ambient concentrations for vinyl chloride were well below the State ambient air quality standard at five of them which were chosen for ambient testing. As yet, there is no State ambient air quality standard for benzene.

The study discusses a known action that takes place in landfills, whereby buried materials undergo bacterial decomposition and generate gases for decades after closure. Although that is a known phenomenon, what is still not known is how vinyl chloride was generated in these Class II landfills. Although the report postulates a probable process for vinyl chloride generation, there is no attempt to offer proof since that lies outside the scope of the study. There is also no attempt to explain the presence of aromatic hydrocarbons.

The most perceptible impact from these landfills on the surrounding populace seems to be odors. The report also states that migrating methane could be a problem if this gas migrates beyond the landfill property line and becomes trapped in enclosed spaces, presenting a potential explosive hazard. This hazard has been recognized for years and other agencies have regulations which require containment of these gases at the landfill perimeter.

Questions regarding the report should be addressed to Dr. Margil W. Wadley, at (818) 572-6452.

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HAZARDOUS POLLUTANTS IN CLASS II LANDFILLS

A Research Report

by

John A. Wood
and
Michael L. Porter

Laboratory Services Branch

Technical Services Division

December 1986

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

HAZARDOUS POLLUTANTS IN CLASS II LANDFILLS

Research and Report

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Many people contributed to the development of this paper. Earl Roberts supervised the field portion of the ambient monitoring program. An expert in micrometeorology, his insight and explanations were very valuable. Richard Schneider and Steve Marinoff were responsible for the source testing of the landfills. Dr. Freeman Allen provided valuable discussion and documentation regarding the biological origin of various halogenated organic compounds in landfills. Laboratory staff members Steve Barbosa, Tai-Ching Hu, Allan Larm, Violeta Vita, and Fred Thomas provided essential analytical services. Sandra Hom, Danya Waggoner, Mary Ann Drake, and Lani Montojo prepared the final typescript.

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SUMMARY

This laboratory has observed a wide variety of volatile organic compounds in gas samples from Class II landfills. These include vinyl chloride, a fairly complete set of chlorinated solvents, benzene, toluene, other aromatics, saturated hydrocarbons, plus some oxygenated solvents, methyl ethyl ketone, and methyl isobutyl ketone.

The ambient air was monitored in the vicinity of five of the landfills. Measurable amounts of vinyl chloride were found in the ambient air around only one landfill, but there were no exceedances of the State 24-hour Standard of 10 ppb. However, air monitoring occurred in the winter/spring when conditions are not likely to produce the highest 24-hour measurements. One of the chief complaints submitted by the residents living near landfills has been the odors. The human sense of smell is much more sensitive to the presence of many compounds, particularly mercaptans and thiophenes, than some laboratory equipment.

In California, Class II landfills are not permitted to accept, in any quantity, any of the compounds mentioned above. It is obvious that these compounds entered the landfills illegally or were produced in the landfill. Vinyl chloride or benzene was found in 85% of the Class II landfills in this study. In more than half of these Class II landfills, the concentration of vinyl chloride or benzene was 1 ppm or higher. It is probable that this is a nationwide problem. The maximum concentrations found in this study are shown in Table I.

TABLE I

Maximum Concentrations of Specific Components
(From All 20 Landfills)

Component	Max. Conc. (ppm)
Methane	587,000
Carbon Dioxide	453,000
Vinyl Chloride	44
Benzene	32
Toluene	150
t-1,2-DCEE[1]	59
$CHCl_3$	0.61
1,2-DCE[2]	19
1,1,1-TCE[3]	3.6
CCl_4	0.011
TCEE[4]	13
Perchloroethylene	19

1) t-1,2-dichloroethene
2) 1,2-dichloroethane
3) 1,1,1-trichloroethane
4) trichloroethene

TABLE II

Relative Values of Methane and Vinyl Chloride at Various Sites

(Concentrations in ppm)

Landfill	Site	Methane	Vinyl Chloride	CH_4/VC X $10+^{3}$
Scholl Canyon	1	516,000	28	18
	2	67,200	9.6	7
	3	16,600	0.61	27
Coyote Canyon	1	530,000	1.2	440
	2	296,000	6.5	46
Toyon Canyon	1	564,000	0.47	1200
	2	587,000	0.34	1700
	3	559,000	0.24	2300
Mountaingate	1	266,000	2.6	100
	2	245,000	7.2	34
	3	463,000	22	21
Syufy	1	529,000	5.0	110
	2	329,000	2.4	140
	3	292,000	0.73	400
	4	365,000	1.7	210

The problems with using manifests to determine the presence of specific organic compounds in Class II landfills are:

1) Manifests are too general. They usually refer to a type of refuse and are not the result of a chemical analysis. The inaccuracy of manifests is evident by what has been found in landfill gas. If any of the halogenated or aromatic compounds observed by this laboratory had been listed on the manifest, the material would have required disposal in a Class I landfill. This does not mean that there is a great deal of intentional illegal disposal. Most of the prohibited substances probably entered the landfills because of careless disposal by homeowners and by small businessmen who may not be aware of legal restrictions on what is allowed in municipal trash.

2) The chemical composition of a landfill is not static. As microorganisms digest the organic material in the landfill, they manufacture a large number of organic compounds. Dr. Freeman Allen, Professor of Chemistry at Pomona College and Chairman of the District's Advisory Council, performed some experiments which showed that bacteria can and do remove chlorine from common solvents. Vinyl chloride is one of the products of that biological process.

At the onset of this study, subsurface gas migration was not a consideration. After this project was initiated, landfill gas migration was found to be a problem at BKK, a Class I landfill, and at Operating Industries, a Class II landfill. In both cases the most immediate danger to nearby residents was high methane concentrations which could approach the explosive limit in confined spaces inside the homes.

Contractors like to use methane as a surrogate for measurement of specific toxics in landfills. Methane cannot be used as a surrogate for vinyl chloride emissions. The relative concentrations of the two compounds vary considerably from site to site within a single landfill. Some sample values found in this study are shown in Table II.

After a careful evaluation of the distribution of toxics and methane within a particular landfill, it may be appropriate to use methane as an indicator of subsurface migration. After migration has been detected, further analysis for toxics is indicated.

INTRODUCTION

The South Coast Air Quality Management District of California has measured gaseous emissions from landfills for a number of years. We first became concerned with toxics in landfill gas a few years ago when we discovered approximately 1000 ppm of vinyl chloride in the gas recovery system of BKK landfill in West Covina. BKK was a Class I landfill, and was allowed to accept toxic materials until December 1, 1984, when the owners voluntarily ceased accepting hazardous wastes. Ambient air monitoring in the neighborhoods adjacent to this landfill showed that the State of California Air Quality Standard for vinyl chloride was being exceeded frequently. The standard is a 24-hour average concentration of 10 ppb. Major additions to the gas collection system have improved this situation.

After the experience with BKK, analysis for vinyl chloride at several Class II landfills was performed. Vinyl chloride was found to be present in concentrations up to 60 ppm. This was a much lower concentration than at BKK, but we felt it was far too high for a Class II site. Class II landfills are for municipal waste and are not allowed to accept toxic materials.

At first it was thought that the vinyl chloride was present because of illegal dumping by a producer or consumer of vinyl chloride. However, since vinyl chloride was found at site after site, it appeared that the vinyl chloride was getting into landfills by some other mechanism. Our first impulse was to check the manifests to see if we could locate the source of the contamination. However, this approach was useless.

As we were further able to characterize gases from additional landfills, it became ever more apparent that there is little one can do to predict the toxicity of landfill gas at a particular site. Each landfill is unique. Toxics were found in several active Class II landfills. One, Operating Industries, produced ambient air 24-hour concentrations of vinyl chloride in excess of the State's standard in nearby neighborhoods. The EPA Region IX office became concerned enough to give the District a grant to support an investigation of 20 Class II landfills. The results of the study are the subject of this report.

Sampling Methods

1. Landfill Gas Sampling

Some landfills have gas collection systems to control emissions. Typically this consists of pipes buried in a network of covered, gravel-filled trenches. The pipes have numerous holes in their sides. Landfill gas is pulled into and through the pipes by a blower. The exhaust from the blower, which is raw landfill gas, may go to a flare, an internal combustion engine, or a treatment facility.

A. Gas Collection System Present

When a gas collection system was present, samples were taken from the system at appropriate locations with 2-liter evacuated glass bulbs. The glass bulbs are spherical with an open 4-inch long by 10 mm diameter glass tube attached. Approximately 4 inches of heavy-walled gum rubber tubing was fitted over the end, and a pinch clamp was placed on the gum rubber tubing.

The procedure for using the 2-liter bulbs was as follows: clean the inside of the glass bulb with sulfuric acid/potassium dichromate cleaning solution. Rinse thoroughly with deionized water and dry in an oven at 120°C.

After the bulb was dry, it was cooled to room temperature and the body of the bulb covered with plastic netting. This was to protect the operator from implosion. The gum rubber tubing was then placed over the end of the glass tube and the pinch clamp put in place. The completed bulb assembly was then evacuated just prior to being taken out into the field.

When the source test engineers took samples from the gas collection system, they first inserted a line into the collection system. The glass bulb was attached to the side of the line and a small hand pump was used to fill the line with landfill gas. This prevented dilution of the sample by ambient air remaining in the line. The pinch clamp was then opened and the landfill gas filled the bulb. After waiting about 30 seconds for the bulb to fill completely the pinch clamp was closed and the sample returned to the laboratory for analysis.

B. Gas Collection System Not Present

Field personnel surveyed the surface of the landfill with a hydrocarbon monitor to locate places where the emissions were highest. The sites where high emissions occurred were covered with inverted 5-gallon buckets. Each bucket had a tube connection attached to the closed end. The buckets were left in place about two hours to let them fill with gas, and then a sample was taken with a 2-liter 14evacuated bulb.

2. Ambient Air Sampling

The sampling device used by the District consists basically of a dual tedlar bag sampler with automatic switching. A complete description is given in Appendix A. In brief, ambient air is pumped into an emptied 10-liter tedlar bag at such a rate that about 5 liters are collected over a period of 24-hours. The bags are housed in protective cardboard boxes to exclude light during transport and to protect them from physical damage. The entire sampling system is battery operated and housed in a sturdy, locked metal container to reduce the likelihood of vandalism.

Analytical Methods and Calculations

Chlorinated Hydrocarbons

Analysis was performed on a Hewlett-Packard Model 5700A gas chromatograph with a Ni_{63} electron capture detector. A 10-port valve fitted with a 4 mL loop, pre-column with backflush, and a 50:1 inlet splitter is used for sample injection.

The analytical column was a 30 m x 0.25 mm I.D. DB-1 (methyl silicone), fused silica capillary. The pre-column was 2 ft. x 1/4 inch stainless steel packed with 10% OV-101, 80/100 mesh. Nitrogen was used as carrier at 20 psi inlet pressure. Nitrogen was used as makeup gas with a total flow through the detector of 27 mL/min. The analytical column temperature was 40°C, the pre-column temperature was 150°C, and the detector temperature was 250°C. The retention times were 4.8 minutes for trans-1,2-dichloroethene, 5.8 minutes for chloroform, 6.2 minutes for 1,2-dichloroethane, 6.4 minutes for 1,1,1-trichloroethane, 6.9 minutes for carbon tetrachloride, 8.0 minutes for trichloroethylene, and 15 minutes for perchloroethylene. A sample chromatogram is shown in Figure 1A.

Benzene and Toluene

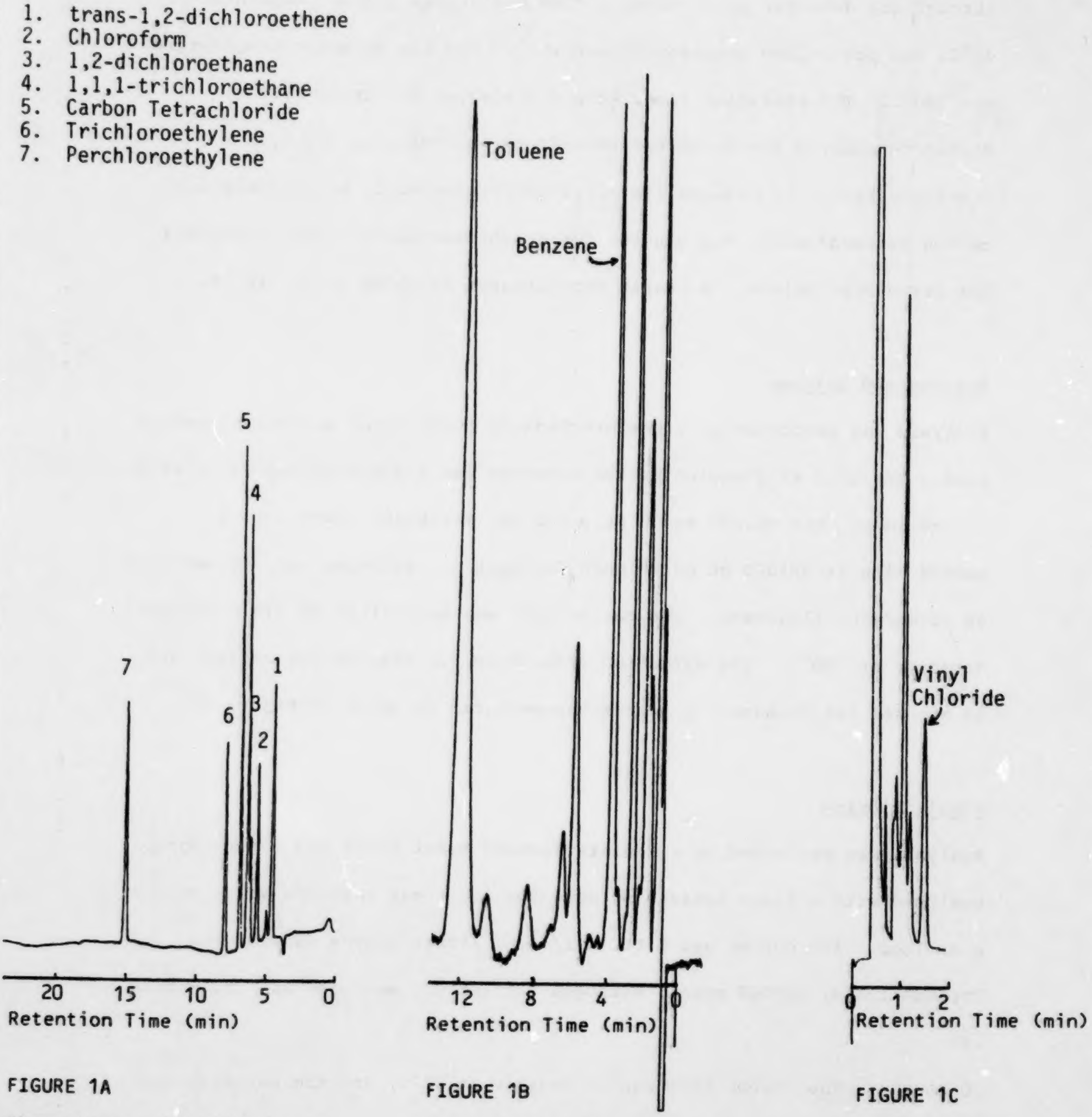
Analysis was performed on a Hewlett-Packard Model 5700A gas chromatograph with a HNu 10.2 eV photoionization detector and a gas sampling valve with a 2 mL loop. The column was 6 ft. x 1/8 in. stainless steel tubing packed with 1% SP1000 on 60/80 mesh Carbopak B. Nitrogen carrier was used at 30 mL/min. flow rate. The column oven was maintained at 170°C and the detector at 190°C. The retention times were 3.9 minutes for benzene and 12 minutes for toluene. A sample chromatogram is shown in Figure 1B.

Vinyl Chloride

Analysis was performed on a Hewlett-Packard Model 5700A gas chromatograph equipped with a flame ionization detector and a gas sampling valve with a 4 mL loop. The column was 6 ft. x 1/4 in. nickel tubing packed with Chromosil 310, 80/100 mesh. Nitrogen carrier gas was used at a flow rate of

70 mL/min. The column oven was maintained at 60°C, and the detector was held at 250°C. The retention time of vinyl chloride under these conditions is 1.5 min. A sample chromatogram is shown in Figure 1C.

FIGURE 1



1. trans-1,2-dichloroethene
2. Chloroform
3. 1,2-dichloroethane
4. 1,1,1-trichloroethane
5. Carbon Tetrachloride
6. Trichloroethylene
7. Perchloroethylene

FIGURE 1A

Chromatogram for Chlorinated Hydrocarbons

FIGURE 1B

Chromatogram for Aromatics

FIGURE 1C

Chromatogram for Vinyl Chloride

Calculations

Component concentrations in unknown samples are determined by comparing strip chart recorder peak heights of samples to that of a calibrated standard using the external standard method.

Three separate high pressure cylinders serve as external standards. They were prepared and certified to ± 2% accuracy by Scott Environmental.

Component concentrations are determined by the calculation:

$$U_c = \frac{S_c \times R_u \times P_F}{R_c \times P_I}$$

where U_c = Concentration of analyzed component

S_c = Concentration of external standard

R_u = Instrument response to analyzed component

R_c = Instrument response to external standard

P_I = Initial pressure of sample bulb

P_F = Final pressure of sample bulb

Landfill Gas Characterization by GC/MS

Volatile non-methane hydrocarbons in raw landfill gas samples were qualitatively identified using an electron impact GC/MS system scanning from M/e^- 38 to 220 every 2.4 seconds with electron multiplier voltage of 200 eV.

Conditions of Analysis:

Instrument: HP 5790 A MSD

GC Column: Standard cross linked methyl silicone capillary supplied with HP 5790 A MSD. (30 m x .032 mm, .25 µl loading)

Carrier: Helium at ~0.8 mL/min.

Split: 10:1

Sample Injection: An external freeze-out trap is plumbed to the carrier inlet line at the split/splitless injection port. The trap consists of a 10-port valve with provisions for isolating a 1/4 inch narrow bore stainless steel U-tube for subsequent cooling and heating in dry ice and boiling water baths.

Landfill gas sample injection volumes range from 10 mL to 200 mL depending upon dilution of the raw landfill gas during sample collection.

Quality Assurance

The cornerstone of our quality assurance program is traceability to the National Bureau of Standards. Whenever possible we purchase NBS standards or standards referenced to NBS standards. We also participate in interlaboratory studies and audits. The results of two recent audits are shown in Tables III and IV.

Sample containers were tested for stability of analytes with respect to storage time. Duplicate and replicate sample analyses were performed to check precision and reproducibility.

Our analytical methods were also checked for reproducibility and linearity.

TABLE III

Results of Benzene Audit

(Concentration in ppb)

CYLINDER	NBS	SCAQMD
1	3.4	3
2	4.9	4.5
3	7.6	6

TABLE IV

Results of Toxics Audit

Concentration in ppb)

Component	EPA	SCAQMD
Chloroform	3.7	4
Benzene	12	11
Perchloroethylene	14	15
Carbon Tetrachloride	15	16
Vinyl Chloride	12	9
Chloroform	37	36
Benzene	20	16
Perchloroethylene	10	10
Carbon Tetrachloride	10	11
Vinyl Chloride	21	18

Standards

The accuracy of our standards was based upon traceability to NBS standards or EPA certified standards. Standardizations for aromatics, chlorinated hydrocarbons, CO_2, and CH_4 were performed as per the appropriate procedures described in the "Analytical Methods and Calculations" section of this report.

Benzene and Toluene

NBS benzene was used as a primary standard. A mixed standard of benzene and toluene produced relative responses of the two compounds. The NBS benzene was then used as a standard for both benzene and toluene analyses in samples.

Vinyl Chloride

Vinyl chloride has a retention time reasonably close to propane on our modified EPA Method 25, FID/TCA analysis system. Vinyl chloride is converted quantitatively to carbon dioxide by Hopcalite at 1200°F. The gas stream, with hydrogen added, is then passed through a nickel catalyst at 300°C to convert the CO_2 to CH_4. The CH_4 is detected by a flame ionization detector. A vinyl chloride working standard was calibrated using NBS propane in the FID/TCA system. Vinyl chloride concentration was calculated on a carbon basis.

Other Chlorinated Hydrocarbons

The other chlorinated hydrocarbons were standardized by calibrating a working standard gas cylinder with EPA audit cylinders provided by EPA Region IX.

CO_2 and CH_4

Carbon dioxide and methane were standardized against their respective NBS standards.

Sampling

The sampling media was evaluated for ability to maintain sample integrity. The Tedlar bags worked well when used for ambient air. They held chlorinated hydrocarbons for at least 8 days (Figure 2), and benzene for at least 30 days[1]. Brominated hydrocarbons were reasonably stable for a few days.

The glass bulbs did not fare so well. They held methane, carbon dioxide and chlorinated hydrocarbons satisfactorily for 3 days, but benzene and toluene disappeared rapidly (See Figure 3). Therefore, these compounds had to be analyzed for benzene and toluene the same day sampling occurred. If this could not be done, the data for aromatics was omitted on the theory that bad data is worse than no data.

The rapid disappearance of benzene and toluene was traced to the gum rubber tubing attached to the bulb. Figure 4 shows that this situation does not arise with an all-glass system. However, field use of the all-glass systems resulted in breakage of 1/4 to 1/3 of the samplers. That breakage rate was very expensive in terms of equipment and lost data. This prompted the use of the glass/rubber systems and to perform the analyses very rapidly to minimize sample loss.

Because of the problem with the bulb samplers, special Tedlar grab samplers developed by Anatec of San Dimas, California, have been used in trial experiments. Preliminary results indicated that these samplers are more

FIGURE 2

EFFECT OF STORAGE ON SAMPLE ANALYSIS

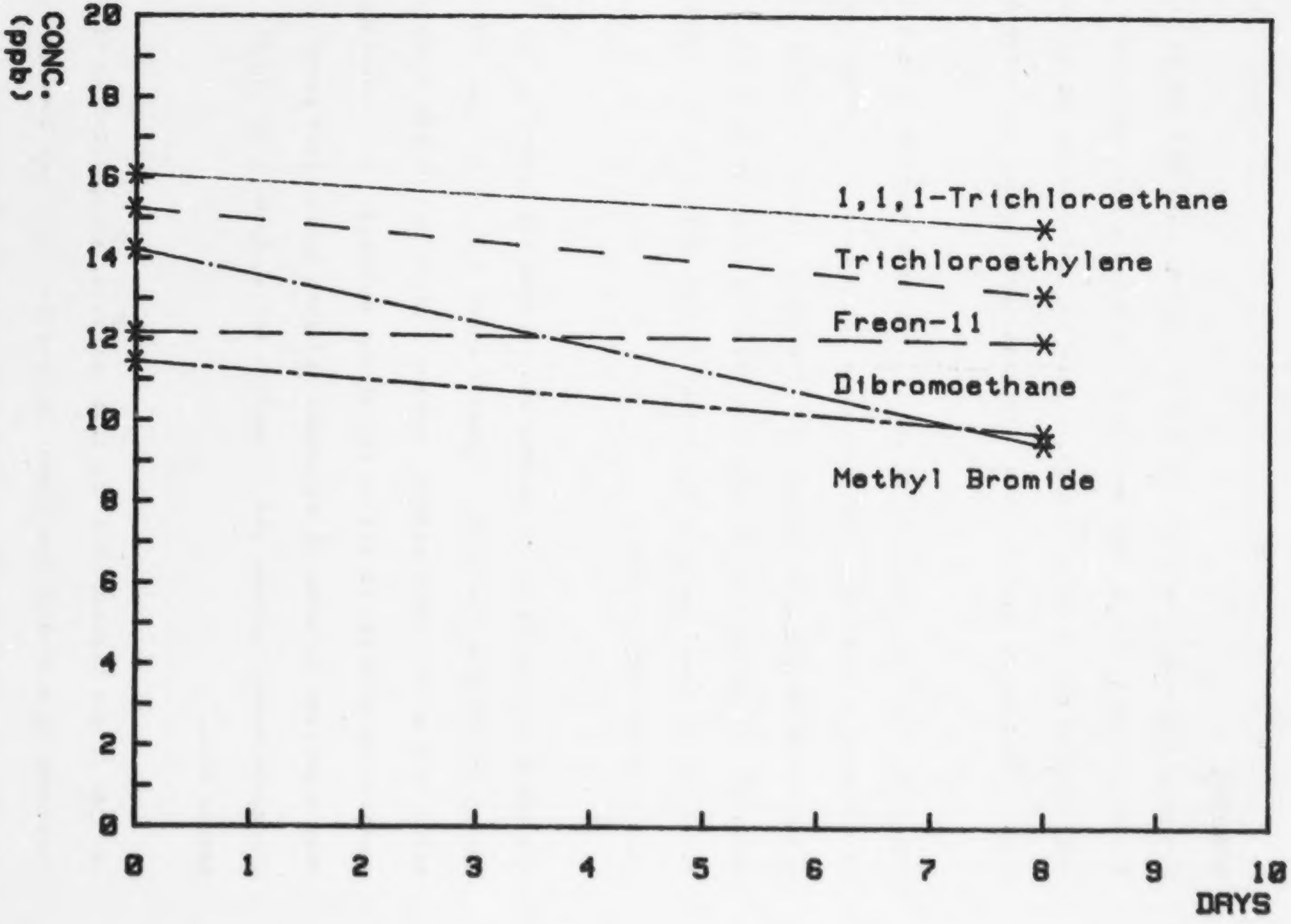


FIGURE 3

Stability of Aromatics in a 2-liter Glass Bulb with Attached Rubber Tube

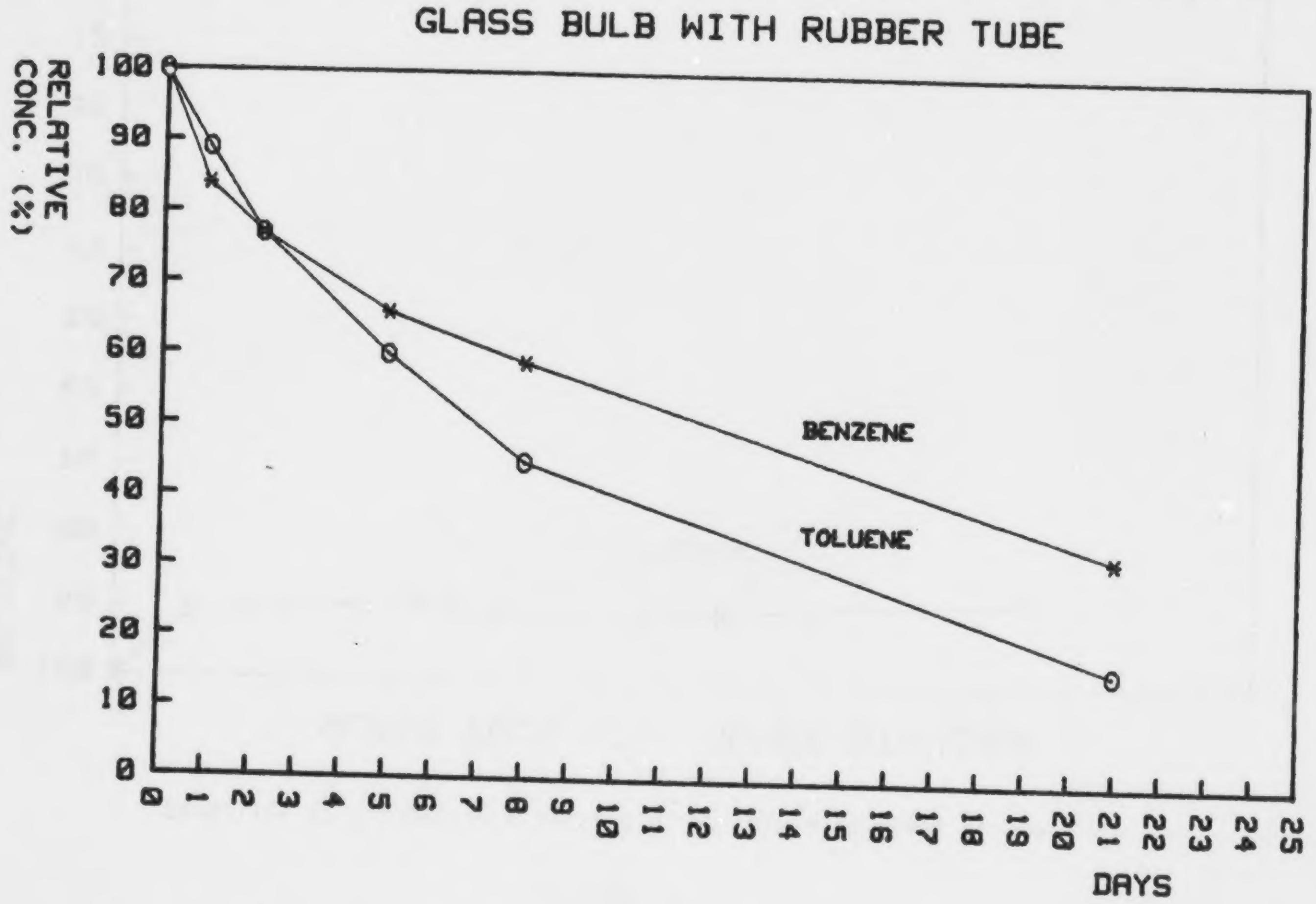
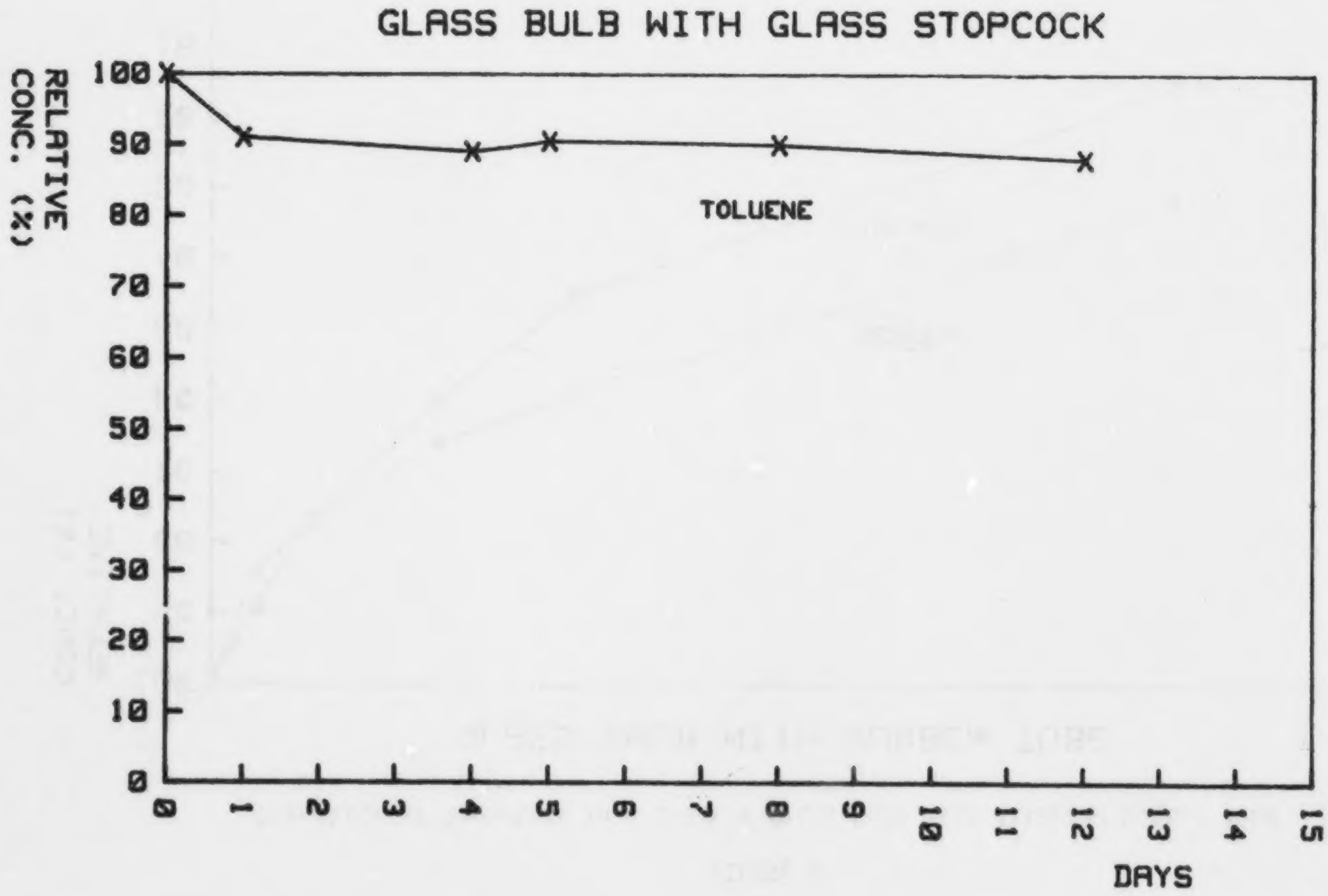


FIGURE 4

Stability of Toluene in a 2-liter glass bulb with glass stopcock.



suited in maintaining sample stability. In addition, these samplers are desirable in that they can withstand rough handling in the field.

Analysis

Samples were injected into the gas chromatographs equipped with stainless steel sampling valves, with stainless steel constant volume loops, without preconcentration of the sample. Loop injection gave very repeatable injections. The omission of a concentration step improved precision and reduced artifacts to a minimum. Earlier experiences with sorbent tubes and cryogenic concentrators had proved less than satisfactory. They can provide high sensitivities, but careful evaluation often showed artifacts and reproducibility problems.

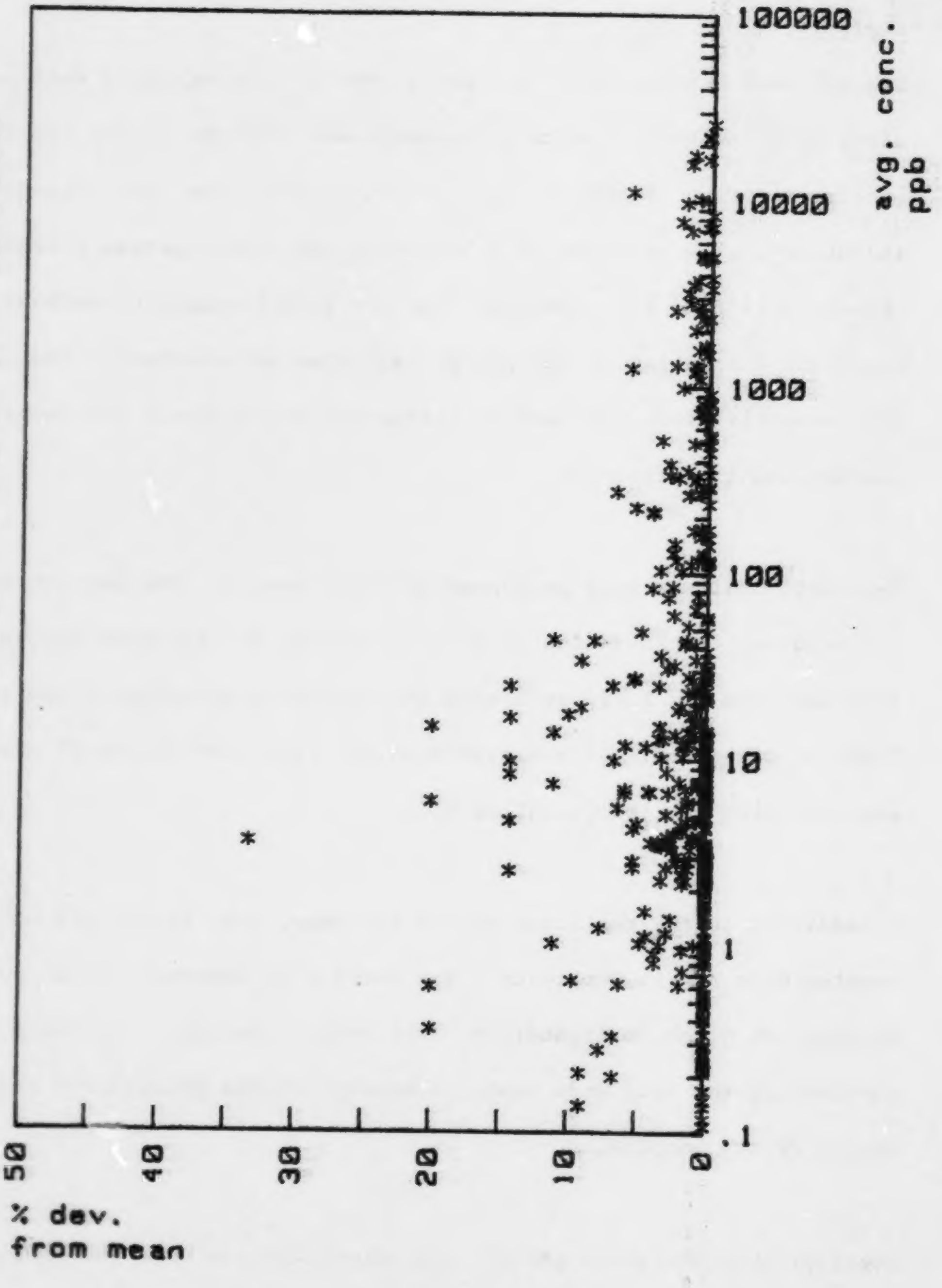
Replicate analyses were performed on every sample. The percent deviation from the mean vs. concentration is shown in Figure 5. The mean percent deviation from the mean was 1.7%, even with the inclusion of values close to the lower limit of detection. This illustrates the very high degree of precision achieved with our analytical methods.

In addition to the replicate sample analyses, over twenty percent of the samples were run in duplicate. The results of analysis of the duplicate samples are given in Appendix B. The overall results were quite good considering the very wide range of concentrations encountered and the complex nature of the samples.

Usually, when one plots percent deviation from the mean vs. concentration, one finds that the greatest percent deviation occurs at the low concentrations.

FIGURE 5

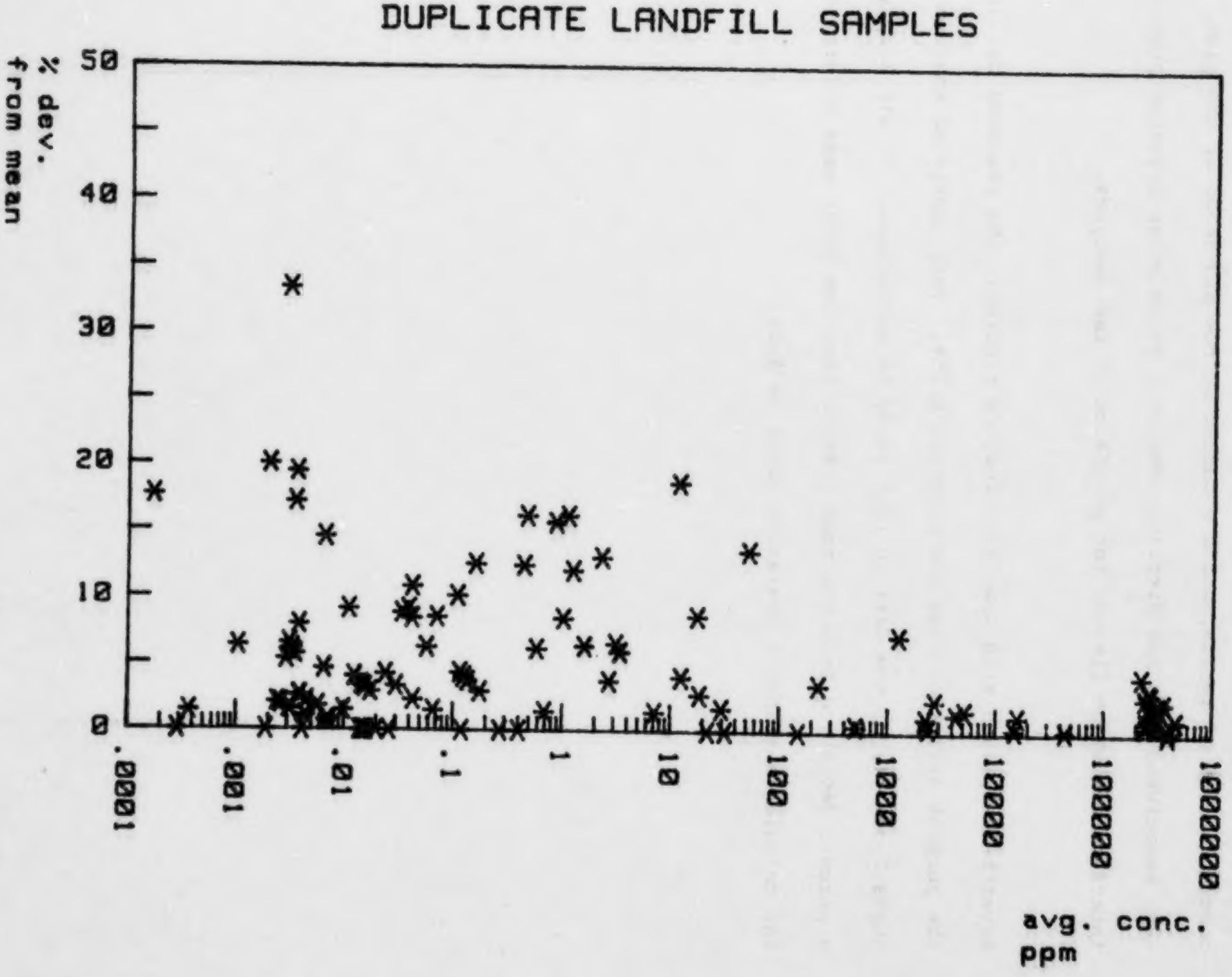
REPLICATE ANALYSES OF LANDFILL SAMPLES



This is because the values approach the lower limit of detection. In this study, the highest percent deviations from the mean tend to occur near the middle of the concentration range (See Figure 6). This is because the highest concentrations of toxics, which occurred in the mid-range of the plot, also were associated with the dirtiest samples. These other organics produced some interferences which limited the precision of the analyses.

Nevertheless, even with some interference problems, the standard deviation of the percent deviation from the mean was 4.86%. This indicated that the overall quality of the data in this study is quite good. If all samples with a percent deviation from the mean greater than 15% (3σ), were eliminated, then the calculated standard deviation would be 3.6%.

FIGURE 6


DUPLICATE LANDFILL SAMPLES
% dev.
from mean
50
40
30
20
10
0
.0001
.001
.01
.1
1
10
100
1000
10000
100000
1000000
avg. conc.
ppm

RESULTS AND DISCUSSION

Landfill Gas Analysis

The results of the landfill gas analyses are given in Table V, and descriptions of the sampling sites, taken from the Source Test Reports, are given in Appendix C. Since all of the landfills tested were Class II (non-toxic) sites, it is remarkable to note the prevalence of toxic materials. Vinyl chloride and/or benzene were found in 85% of the landfills tested, and they were found in concentrations of over 1 ppm in more than half of the landfills.

We tested five active landfills. The gas from all five sites contained vinyl chloride in concentrations over 1 ppm, and all but Redlands had benzene concentrations over 1 ppm. Scholl Canyon had the highest vinyl chloride concentration, 44 ppm, while Calabassas had the highest benzene concentration at 32 ppm.

The relative concentrations of pollutants varied quite a lot from site to site at each landfill. Since contractors like to use methane monitoring as a surrogate for toxics monitoring, the CH_4/vinyl chloride (CH_4/VC) ratio has been included in Table V. A glance through the table shows that this ratio can vary by more than an order of magnitude within a single landfill.

Two of the active landfills, Calabassas and Spadra, were tested before and after the installation of gas collection systems. The absolute concentrations of methane collected in the buckets were much lower than that expected in pure landfill gas, but the relative concentrations of vinyl chloride compared to methane were in the same range as in the pure landfill gas. Therefore, within

TABLE V

Calabasas
(Active Landfill)

(Concentration in ppm)

Site	Buck.#3	Buck.#4	Buck.#2	Buck.#1	KP	PD
Methane	506	1780	360	202	310000	324000
Carbon Dioxide	981	2600	1390	1310	295000	299000
Vinyl Chloride	<0.020	0.059	<0.020	<0.020	29	30
Benzene	<0.005	<0.010	<0.005	<0.005	32	32
Toluene	0.021	0.019	0.015	0.015	150	150
t-1,2-DCEE	NA	NA	NA	NA	45	59
$CHCl_3$	<0.0015	<0.0015	<0.0015	<0.0015	0.54	0.61
1,2-DCE	NA	NA	NA	NA	18	19
1,1,1-TCE	0.0037	0.0034	0.0035	0.0054	3.2	3.6
CCl_4	0.00021	0.00022	0.00022	0.00021	<0.04	<0.04
TCEE	0.0028	0.0045	0.0021	0.0020	12	13
Perchloroethylene	0.0080	0.0050	0.0037	0.0036	16	19
$CH_4/VC\ X10^{-3}$	>25	30	>18	>10	11	11

Comments

The first four samples were taken 8-3-84 by the bucket method prior to the installation of a gas collection system. Samples KP & PD were taken 9-4-85 from the flare inlet.

TABLE V (Cont.)

Scholl Canyon
(Active Landfill)

(Concentration in ppm)

Site	**KX**	**660**	**EX**	**RT**	**943**	**258**
Methane	516000	67200	16600	547000	<10	<10
Carbon Dioxide	403000	54600	13400	417000	503	508
Vinyl Chloride	28	9.6	0.61	44	<0.020	<0.020
Benzene	3.6	0.40	<0.005	3.9	<0.007	<0.007
Toluene	47	7.1	0.040	30	0.020	0.020
t-1,2-DCEE	6.6	0.33	<0.054	<1.5	<0.045	<0.045
$CHCl_3$	0.50	0.019	0.0054	0.40	<0.0009	<0.0009
1,2-DCE	0.35	0.28	<0.010	<0.25	<0.035	<0.035
1,1,1-TCE	1.0	0.031	0.0068	0.24	0.0075	0.0056
CCl_4	0.0028	<0.0005	0.00023	0.0028	0.00020	0.00014
TCEE	2.4	0.19	0.0051	1.8	0.0011	0.00097
Perchloroethylene	4.4	0.12	0.012	4.3	0.0041	0.0029
CH_4/VC $X10^{-3}$	18	70	27	12		

Comments: No gas collection system. Tested four times from 9-27-84 to 11-30-84. Bucket Method.

TABLE V (Cont.)

Scholl Canyon

(Active Landfill)

(Concentration in ppm)

Site	**Point #3**	**Point #4**	**Point #5**
Methane	**856**	**207**	**70**
Carbon Dioxide	**1130**	**621**	**537**
Vinyl Chloride	**0.057**	**0.035**	**<0.010**
Benzene	**NA**	**NA**	**NA**
Toluene	**NA**	**NA**	**NA**
t-1,2-DCEE	**<0.012**	**<0.012**	**<0.012**
$CHCl_3$	**<0.0004**	**0.00061**	**0.00060**
1,2-DCE	**<0.009**	**0.009**	**<0.009**
1,1,1-TCE	**0.0048**	**0.0061**	**0.0058**
CCl_4	**0.00062**	**0.00084**	**0.00074**
TCEE	**0.0047**	**0.0012**	**0.00092**
Perchloroethylene	**0.014**	**0.0028**	**0.0024**
CH_4/VC $X10^{-3}$	**15**	**5.9**	**>7**
Comments	**No gas collection system. Tested four times from 9-27-84 to 10-30-84. Bucket method.**		

TABLE V (Cont.)

Coyote Canyon

(Active Landfill)

Concentration in ppm)

Site	**YS**	**SQ**	**GD**	**FL**	**936**
Methane	2870	42100	530000	5750	296000
Carbon Dioxide	2940	36400	421000	4720	310000
Vinyl Chloride	0.23	0.40	1.20	0.20	6.50
Benzene	0.019	0.11	2.60	0.030	1.60
Toluene	0.18	1.10	88.0	0.44	14.0
t-1,2-DCEE	<0.090	<0.090	3.90	<0.060	26.0
$CHCl_3$	<0.0013	<0.0013	<0.0040	<0.0010	<0.33
1,2-DCE	<0.030	<0.030	0.24	<0.014	<6.0
1,1,1-TCE	0.0067	0.032	0.15	0.0033	1.30
CCl_4	0.00021	0.00015	<0.00050	0.00021	<0.045
TCEE	0.0066	0.13	7.80	0.012	1.30
Perchloroethylene	0.014	0.084	17.0	0.025	1.20
CH_4/VC X10^{-3}	12	100	440	29	46

Comments Tested 8-28-84. No gas collection system. Bucket Method.

TABLE V (Cont.)

Spadra
(Active Landfill)

(Concentration in ppm)

Site	**4**	**7**	**10**	**11**	**Inlet**
Methane	1190	224	5100	186	217000
Carbon Dioxide	1600	899	6030	788	338000
Vinyl Chloride	0.062	<0.010	0.077	<0.010	<1.90
Benzene	0.005	<0.005	0.012	0.002	0.82
Toluene	0.016	0.014	0.017	0.011	19.0
t-1,2-DCEE	NA	NA	NA	NA	<0.009
$CHCl_3$	<0.0005	<0.0005	0.00061	<0.0005	0.13
1,2-DCE	NA	NA	NA	NA	0.098
1,1,1-TCE	0.012	0.0065	0.0055	0.0067	5.0
CCl_4	0.00033	0.00027	0.00027	0.00028	<0.005
TCEE	0.0017	0.0013	0.0033	0.0011	2.70
Perchloroethylene	0.0026	0.0026	0.0024	0.0024	3.0
CH_4/VC X10^{-3}	19	>22	66	>19	

Comments Sampled 7-23-84 by the bucket method prior to installation of gas collection system. Inlet was sampled 5-25-85.

TABLE V (Cont.)

Redlands

(Active Landfill)

(Concentration in ppm)

Site	**D**	**C**	**B**	**A**
Methane	2590	55100	126000	215000
Carbon Dioxide	8800	57100	108000	248000
Vinyl Chloride	<0.003	2.20	0.81	0.54
Benzene	<0.004	0.022	0.005	<0.004
Toluene	<0.007	0.022	<0.007	<0.007
t-1,2-DCEE	<0.005	<0.005	<0.005	<0.005
$CHCl_3$	0.061	0.0051	0.00039	0.00063
1,2-DCE	<0.0035	0.017	0.010	0.021
1,1,1-TCE	0.0049	0.0052	0.0043	0.0048
CCl_4	0.00014	0.00010	0.000097	0.00008
TCEE	0.0016	0.014	0.0012	0.0015
Perchloroethylene	0.0038	0.018	0.0016	0.0018
CH_4/VC X10^{-3}	>860	25	160	400

Comments Tested 4-5-85. No gas collection system. Bucket method.

TABLE V (Cont.)

Toyon Canyon

(Concentration in ppm)

Status: Closed 1983

Site	**ML**	**SV**	**CM**	**IN**	**No Tag**
Methane	564000	558000	544000	587000	559000
Carbon Dioxide	420000	422000	433000	393000	421000
Vinyl Chloride	0.47	<0.22	<0.07	0.34	0.24
Benzene	<0.15	<0.15	0.50	0.56	<0.15
Toluene	5.2	8.8	1.7	12.0	28.0
t-1,2-DCEE	NA	NA	NA	NA	NA
$CHCl_3$	0.022	NA	NA	NA	0.29
1,2-DCE	NA	NA	NA	NA	NA
1,1,1-TCE	0.021	NA	0.007	0.091	0.52
CCl_4	0.002	NA	0.0003	0.0002	0.011
TCEE	0.11	0.51	0.023	0.14	1.7
Perchloroethylene	0.041	0.20	0.008	0.023	1.9
CH_4/VC X10^{-3}	1200	>2500	>7800	1700	2300
Comments	This landfill accepted only household refuse. Samples were taken from the gas collection system.				

TABLE V (Cont.)
West Riverside

(Concentration in ppm)

Status: Closed 1983

Site	**Bucket**			
	2	3	4	1
Methane	696	80	190	97
Carbon Dioxide	1200	557	1090	697
Vinyl Chloride	0.01	<0.01	<0.01	<0.01
Benzene	NA	NA	NA	NA
Toluene	NA	NA	NA	NA
t-1,2-DCEE	<0.030	<0.030	<0.030	<0.030
$CHCl_3$	0.00042	0.00047	0.00041	0.00044
1,2-DCE	<0.011	<0.011	<0.011	<0.011
1,1,1-TCE	0.0070	0.0075	0.0061	0.0072
CCl_4	0.00057	0.00066	0.00052	0.00063
TCEE	0.0012	0.00080	0.0010	0.0011
Perchloroethylene	0.0039	0.0035	0.0029	0.0034
CH_4/VC X10^{-3}	70	>8	>19	>10

Comments Tested 7-27-84. No gas collection system. Bucket method.

TABLE V (Cont.)
Mountain Gate

(Concentration in ppm)

Status: Closed 1981

Site	**GT**	**NU**	**FL**	**SQ**	**CD**	**968**
Methane	266000	257000	245000	232000	463000	453000
Carbon Dioxide	240000	243000	229000	210000	390000	390000
Vinyl Chloride	2.6	2.8	7.2	7.0	22	22
Benzene	0.098	0.12	0.40	0.40	1.10	0.93
Toluene	0.39	0.54	3.3	2.9	14	9.6
t-1,2-DCEE	NA	NA	NA	NA	NA	NA
$CHCl_3$	NA	NA	NA	NA	NA	NA
1,2-DCE	<0.043	<0.048	0.12	0.11	<0.37	<0.37
1,1,1-TCE	0.004	0.002	<0.001	0.002	0.026	0.026
CCl_4	NA	NA	NA	NA	NA	NA
TCEE	0.038	0.045	0.18	0.14	1.4	1.1
Perchloroethylene	0.037	0.046	0.13	0.12	1.3	0.94
CH_4/VC X10^{-3}	100	92	34	33	21	21

Comments Tested 3-15-84. Gas collection system to flares.

TABLE V (Cont.)

Upland

(Concentration in ppm)

Status: Closed 1979

Site	**JD**	**176**	**UC**
Methane	**369000**	**404000**	**513000**
Carbon Dioxide	**344000**	**378000**	**453000**
Vinyl Chloride	**10.0**	**9.6**	**16.0**
Benzene	**0.32**	**0.47**	**0.71**
Toluene	**2.6**	**2.9**	**18.0**
t-1,2-DCEE	**<0.18**	**<0.18**	**<0.009**
$CHCl_3$	**<0.0030**	**<0.0030**	**0.00034**
1,2-DCE	**<0.060**	**<0.060**	**<0.007**
1,1,1-TCE	**0.010**	**0.011**	**0.017**
CCl_4	**0.00069**	**0.00069**	**<0.00003**
TCEE	**0.27**	**0.34**	**0.110**
Perchloroethylene	**0.29**	**0.33**	**0.074**
CH_4/VC $X10^{-3}$	**37**	**42**	**32**

Comments

Tested 8-24-84 and 3-28-85.
Gas collection system feeds to
internal combustion engine.

TABLE V (Cont.)

Valley Reclamation

(Concentration in ppm)

Status: Closed 1976

Site	**Flare Inlet**
Methane	173000
Carbon Dioxide	255000
Vinyl Chloride	1.1
Benzene	1.1
Toluene	2.1
t-1,2-DCEE	<0.12
$CHCl_3$	<0.0025
1,2-DCE	<0.070
1,1,1-TCE	0.0099
CCl_4	<0.00030
TCEE	0.32
Perchloroethylene	0.36
CH_4/VC X10^{-3}	1600
Comments	Tested 2-8-85. Gas collection system. Sample collected at flare inlet.

TABLE V (Cont.)

Sheldon Arleta

(Concentration in ppm)

Status: Closed 1974

Site	204	S22	TB	562
Methane	395000	393000	278000	262000
Carbon Dioxide	322000	335000	236000	220000
Vinyl Chloride	<0.050	<0.050	<0.050	<0.050
Benzene	0.12	0.12	0.50	0.39
Toluene	0.70	0.68	2.6	2.0
t-1,2-DCEE	<0.35	<0.35	<0.25	<0.25
$CHCl_3$	<0.0035	<0.0035	<0.0030	<0.0030
1,2-DCE	<0.12	<0.12	<0.095	<0.095
1,1,1-TCE	0.0027	0.0030	0.0041	0.0041
CCl_4	<0.00070	<0.00070	<0.00050	<0.00050
TCEE	0.060	0.053	0.077	0.065
Perchloroethylene	0.037	0.031	0.042	0.035
CH_4/VC X10^{-3}	>7900	>7900	>5600	>5200

Comments Tested 7-10-84. Gas collection system with flares.

TABLE V (Cont.)

Kobra

(Concentration in ppm)

Status: Closed 1972

Site	**Bucket**	**A**	**B**	**C**	**D**
Methane		80400	1380	2090	5910
Carbon Dioxide		52100	1360	1770	3720
Vinyl Chloride		7.3	0.031	<0.025	<0.025
Benzene		1.1	0.006	<0.005	<0.005
Toluene		1.3	0.024	0.017	0.010
t-1,2-DCEE		<0.06	<0.06	<0.06	<0.06
$CHCl_3$		0.022	<0.001	<0.001	<0.001
1,2-DCE		<0.025	<0.025	<0.025	<0.025
1,1,1-TCE		0.0028	0.0027	0.0022	0.0039
CCl_4		0.00015	0.00011	0.00011	0.00042
TCEE		NA	<0.001	<0.001	0.001
Perchloroethylene		0.0023	0.0016	0.0014	0.0021
CH_4/VC X10^{-3}		11	45	>84	>240

Comments Tested 9-21-84. Bucket method. No gas collection system.

TABLE V (Cont.)

Gilmour Mud Sump

(Concentration in ppm)

Status: Closed 1972

Site	Bucket No. 1	Bucket No. 2
Methane	5190	5020
Carbon Dioxide	4330	4210
Vinyl Chloride	<0.020	<0.020
Benzene	0.065	0.067
Toluene	0.140	0.130
t-1,2-DCEE	<0.035	<0.035
$CHCl_3$	0.0046	0.0044
1,2-DCE	<0.030	<0.030
1,1,1-TCE	0.0023	0.0024
CCl_4	<0.00009	<0.00009
TCEE	<0.0006	<0.0006
Perchloroethylene	0.0019	0.0019
CH_4/VC X10^{-3}	>220	>250

Comments Tested 10-11-84. No gas collection system. Bucket method. Site was used to store drilling mud. The oily mud was reported to have been excavated prior to 1977. The current owner has found several oil-contaminated sites, and trenched 3' down into one of these for this test.

TABLE V (Cont.)

Syufy Enterprises

(Concentration in ppm)

Status: Closed 1971

Site	**Center**	**Peripheral**	**14C**	**963**	**808A**	**224**	**999**	**936**
Methane	529000	329000	454000	465000	283000	292000	365000	348000
Carbon Dioxide	335000	242000	289000	300000	241000	246000	267000	247000
Vinyl Chloride	5.0	2.4	3.2	3.6	1.0	0.73	1.7	1.5
Benzene	3.1	1.2	NA	NA	NA	NA	NA	NA
Toluene	7.0	0.78	NA	NA	NA	NA	NA	NA
t-1,2-DCEE	NA	NA	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
$CHCl_3$	NA	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
1,2-DCE	0.51	<0.025	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035
1,1,1-TCE	0.010	0.013	0.010	0.0097	0.014	0.014	0.013	0.012
CCl_4	NA	NA	0.00029	0.00029	0.00029	0.00029	0.00037	0.00036
TCEE	0.12	0.027	0.0016	0.0024	<0.001	<0.001	<0.001	<0.001
Perchloroethylene	0.028	0.017	0.0031	0.0030	0.0035	0.0031	0.0031	0.0030
CH_4/VC X10^{-3}	110	140	140	130	280	400	210	230

Comments Report of illegal dumping in 1981. Tested 2-1-84 and 12-7-84.
Gas collection system present.

TABLE V (Cont.)

Kalico #2

(Concentration in ppm)

Status: Closed 1962

Site	**A**	**F**
Methane	23800	2070
Carbon Dioxide	68000	3060
Vinyl Chloride	<0.02	<0.02
Benzene	0.005	0.005
Toluene	0.034	0.014
t-1,2-DCEE	<0.03	<0.03
$CHCl_3$	0.0029	<0.00065
1,2-DCE	<0.022	<0.022
1,1,1-TCE	0.0068	0.0049
CCl_4	0.00017	0.00017
TCEE	0.0037	0.00051
Perchloroethylene	0.010	0.0023
CH_4/VC $X10^{-3}$	>1200	>100

Comments Tested 10-18-84. Bucket method. No gas collection system.

TABLE V (Cont.)

Kalico #1

(Concentration in ppm)

Status: Inactive, close date unknown

Site	**#1**	**#3**	**#11**	**#13**
Methane	362000	14500	17400	81600
Carbon Dioxide	194000	7510	10900	45600
Vinyl Chloride	2.9	1.2	<0.010	<0.010
Benzene	0.039	0.008	0.007	0.006
Toluene	0.120	0.006	0.015	0.012
t-1,2-DCEE	<0.025	<0.025	<0.025	<0.025
$CHCl_3$	<0.0005	0.00064	0.0010	0.0007
1,2-DCE	<0.0016	<0.0016	<0.0016	<0.0016
1,1,1-TCE	0.0059	0.0071	0.0071	0.0070
CCl_4	0.00096	0.00097	0.0010	0.0010
TCEE	NA	0.0010	0.0012	0.0010
Perchloroethylene	0.0024	0.0022	0.0025	0.0024
CH_4/VC X10^{-3}	120	12	>1700	>8200

Comments Tested 9-28-84. No gas collection system. Bucket method.

TABLE V (Cont.)

Russel Moe

(Concentration in ppm)

Status: Closed 1957

Site	**#1**	**#2**
Methane	310000	300000
Carbon Dioxide	245000	234000
Vinyl Chloride	<0.21	<0.21
Benzene	0.030	0.027
Toluene	0.057	0.028
t-1,2-DCEE	<0.042	<0.042
$CHCl_3$	<0.00070	<0.00070
1,2-DCE	<0.015	<0.015
1,1,1-TCE	0.0059	0.0038
CCl_4	0.00012	0.00009
TCEE	0.00087	0.0023
Perchloroethylene	0.0028	0.0025
CH_4/VC X10^{-3}	>1500	>1400

Comments Tested 9-14-84. No gas collection system. Bucket method.

TABLE V (Cont.)

Adams Industries

(Concentration in ppm)

Status: Closed (date unknown)

Site	**SN**	**FS**	**TA**	**BG**
Methane	<10	<10	<10	<10
Carbon Dioxide	458	391	401	413
Vinyl Chloride	NA	NA	NA	NA
Benzene	NA	NA	NA	NA
Toluene	NA	NA	NA	NA
t-1,2-DCEE	NA	NA	NA	NA
$CHCl_3$	NA	NA	NA	NA
1,2-DCE	NA	NA	NA	NA
1,1,1-TCE	NA	NA	NA	NA
CCl_4	NA	NA	NA	NA
TCEE	NA	NA	NA	NA
Perchloroethylene	NA	NA	NA	NA
CH_4/VC X10^{-3}				

Comments Tested 4-18-85. Methane and carbon dioxide values were normal for ambient air. Therefore, no further analyses were performed. Landfill has a hard clay top. Gas migration is off-site. Perimeter gas collection system to be installed.

TABLE V (Cont.)

Davis

(Concentration in ppm)

Status: Closed 1953

Site	**SJ**	**SW**	**SU**	**5**	**ABC**	**9601**	**MMO**
Methane	15000	14900	2220	2270	<10	<10	<10
Carbon Dioxide	44300	44100	16100	15700	2360	2380	2770
Vinyl Chloride	0.27	0.27	0.010	0.012	<0.002	<0.002	<0.002
Benzene	0.044	0.042	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	0.17	0.18	0.029	0.031	0.018	0.017	0.016
t-1,2-DCEE	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
$CHCl_3$	0.0025	0.0026	0.0056	0.0058	0.0043	0.0044	<0.001
1,2-DCE	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
1,1,1-TCE	0.0043	0.0029	0.0033	0.0029	0.0037	0.0039	0.0038
CCl_4	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
TCEE	0.015	0.015	0.0033	0.0037	<0.001	<0.001	<0.001
Perchloroethylene	0.023	0.025	0.014	0.015	0.0068	0.0069	0.0073
CH_4/VC X10^{-3}	56	55	220	190			

Comments Tested 5-16-84. Gas collection system plus perimeter open vents.

TABLE V (Cont.)

Davis (cont.)

(Concentration in ppm)

Site	**999**	**808A**	**244**	**Inlet**	**Well**	**Bucket**
Methane	<10	<10	<10	20300	34700	<10
Carbon Dioxide	2640	1340	1160	58300	69400	1750
Vinyl Chloride	<0.002	<0.002	<0.002	0.12	0.049	<0.012
Benzene	<0.005	<0.005	<0.005	0.013	0.045	0.006
Toluene	0.016	0.016	0.015	<0.010	0.039	<0.010
t-1,2-DCEE	<0.12	<0.12	<0.12	<0.055	<0.060	<0.055
$CHCl_3$	<0.001	<0.001	<0.001	0.0024	0.0071	0.0016
1,2-DCE	<0.030	<0.030	<0.030	<0.040	<0.040	<0.040
1,1,1-TCE	0.0040	0.0035	0.0041	0.0088	0.0084	0.0076
CCl_4	<0.0003	<0.0003	<0.0003	0.00023	0.00024	0.00024
TCEE	<0.001	<0.001	<0.001	0.0034	0.0099	<0.001
Perchloroethylene	0.0072	0.0062	0.0068	0.0075	0.027	0.0059
CH_4/VC $X10^{-3}$			170	710		

Comments Samples 999, 808A, and 244 were sampled by bucket method prior to 1985. Samples Inlet, Well, and Bucket were tested on January 10, 1985.

TABLE V (Cont.)

Velle Circuits

(Concentration in ppm)

Status: Closed 1981

Site
Methane
Carbon Dioxide
Vinyl Chloride
Benzene
Toluene
t-1,2-DCEE
$CHCl_3$
1,2-DCE
1,1,1-TCE
CCl_4
TCEE
Perchloroethylene
CH_4/VC X10^{-3}

Comments Tested 10-4-84. This is a drum storage area, mostly covered with concrete. Portable instruments showed ambient conditions, so no samples were taken. California DOHS tests of soil showed heavy metals such as chromium, cobalt, and nickel.

limits, it is possible to calculate the approximate concentration of a contaminant in raw landfill gas based on bucket samples. For instance, West Riverside would be expected to have roughly 6 ppm vinyl chloride in its raw landfill gas if we assume CH_4 to be 400,000 ppm. We must reiterate that this is only an order of magnitude approximation.

The CH_4/VC ratio was between 17×10^3 to 400×10^3 in the active landfills and for most of the other landfills in which we found vinyl chloride. Toyon Canyon, which closed in 1983, had an average CH_4/VC ratio of 1700×10^3. Compared with landfills having a more recent disposal activity, the CH_4/VC ratio for Toyon Canyon indicates the presence of relatively less vinyl chloride. The only apparent difference between this and other similar landfills was the source of refuse. Toyon Canyon received only household trash. The others received general municipal trash.

Even very old landfills can contain significant amounts of vinyl chloride. Davis, which has been closed for over thirty years contained nearly 0.3 ppm vinyl chloride. Kobra, closed in 1972, was sampled by the bucket method and analysis showed 7.3 ppm vinyl chloride and 1.1 ppm benzene. The methane concentration was 80,400 ppm in this sample. If Kobra's raw landfill gas contains 250,000 ppm of methane, we could expect vinyl chloride and benzene concentrations as high as 23 ppm and 3.4 ppm, respectively. Again, this is only a rough approximation, and the values could be expected to vary significantly around the landfill.

GC/MS Qualitative Analyses of Landfill Gas

In order to illustrate the variability of landfill gas composition among Class II sites, six GC/MS analyses of gas from various sites have been included. The key to peak identifications is given in Table VI, and the compound numbers refer to the peak numbers in Figures 7 through 12.

It can readily be seen that no two sites are alike. They all contain a very large number of organic compounds, some of which are of concern because of possible health problems.

An advantage of GC/MS analyses, when operating in a mode that collects full mass spectra rather than concentrating on selected ions, is that the data can be saved for future study. Therefore, if it is found that additional compounds are hazardous, one can re-evaluate the stored GC/MS data to determine whether or not these additional compounds were present. This can be done without re-sampling the site. Also, historical changes in landfill gas composition may be determined if periodic re-sampling is performed.

COMPOUNDS IDENTIFIED BY GC/MS IN CLASS II LANDFILLS

1. ISOBUTANE
2. VINYL CHLORIDE
3. BUTENE
4. n-BUTANE
5. METHYL MERCAPTAN
6. FLUORODICHLOROMETHANE
7. ISOPENTANE
8. ETHANOL
9. ACETONE
10. n-PENTANE
11. DIMETHYL SULFIDE
12. CARBON DISULFIDE
13. ISOPROPANOL
14. DICHLOROMETHANE
15. METHYL ACETATE
16. t-1,2,-DICHLOROETHENE
17. 2,3,-DIMETHYLBUTANE
18. 1,1-DICHLOROETHANE
19. 2-METHYLPENTANE
20. n-PROPANOL
21. 3-METHYLPENTANE
22. METHYLETHYL KETONE
23. c-1,2-DICHLOROETHENE
24. 2-METHYLFURAN
25. n-HEXANE
26. 2-BUTANOL
27. ETHYL ACETATE
28. METHYL CYCLOPENTANE
29. 1,1,1-TRICHLOROETHANE
30. ISOBUTANOL
31. BENZENE
32. CYCLOHEXANE
33. 1,1,-DIMETHYL CYCLOPENTANE
34. 2-METHYLHEXANE
35. n-BUTANOL
36. 3-METHYLHEXANE
37. METHYLISOBUTANOATE
38. TRICHLOROETHENE
39. DIMETHYLCYCLOPENTANE
40. ISOOCTANE
41. n-HEPTANE
42. METHYLCYCLOHEXANE
43. METHYL BUTANOATE
44. 1,1,3- TRIMETHYLCLOPENTANE
45. PROPYLACETATE
46. ETHYL CLYCLOPENTANE
47. METHYLISOBUTYL KETONE
48. 1,2,4- TRIMETHYLCYCLOPENTANE
49. 1,2,3- TRIMETHYLCYCLOPENTANE
50. TOLUENE
51. 2,3,4-TRIMETHYLPENTANE
52. 2,3,3-TRIMETHLYPENTANE
53. ETHYLISOBUTANOATE
54. 3-ETHYL-2-METHYLPENTANE
55. 2-HEXANOL
56. 1,4, DIMETHYLCYCLOHEXANE
57. ETHYLMETHYLCYCLOPENTANE
58. 1,2,-DIMETHYLCYCLOHEXANE
59. PERCHLOROETHYLENE
60. ETHYLBUTANOATE
61. n-OCTANE
62. CHLOROBENZENE
63. 1,1,3-TRIMETHYLCYCLOHEXANE
64. ETHYLBENZENE
65. 1,2,4-TRIMETHLYCYCLOHEXANE
66. m+p-XYLENE
67. 1,3,5,7-CYCLOOCTATETRAENE
68. o-XYLENE
69. PROPYLBUTANOATE
70. n-NONANE
71. ETHYLTOLUENE
72. α-PINENE
73. TRIMETHYLBENZENE
74. DICHLOROBENZENE
75. 3-CARENE
76. n-DECANE
77. LIMONENE

included. The key to peak identifications is given in Table VI, and the compound numbers refer to the peak numbers in Figures 7 through 12.

It can readily be seen that no two sites are alike. They all contain a very large number of organic compounds, some of which are of concern because of possible health problems.

An advantage of GC/MS analyses, when operating in a mode that collects full mass spectra rather than concentrating on selected ions, is that the data can be saved for future study. Therefore, if it is found that additional compounds are hazardous, one can re-evaluate the stored GC/MS data to determine whether or not these additional compounds were present. This can be done without re-sampling the site. Also, historical changes in landfill gas composition may be determined if periodic re-sampling is performed.

COMPOUNDS IDENTIFIED BY GC/MS IN CLASS II LANDFILLS

1. ISOBUTANE
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6. FLUORODICHLOROMETHANE
7. ISOPENTANE
8. ETHANOL
9. ACETONE
10. n-PENTANE
11. DIMETHYL SULFIDE
12. CARBON DISULFIDE
13. ISOPROPANOL
14. DICHLOROMETHANE
15. METHYL ACETATE
16. t-1,2,-DICHLOROETHENE
17. 2,3,-DIMETHYLBUTANE
18. 1,1-DICHLOROETHANE
19. 2-METHYLPENTANE
20. n-PROPANOL
21. 3-METHYLPENTANE
22. METHYLETHYL KETONE
23. c-1,2-DICHLOROETHENE
24. 2-METHYLFURAN
25. n-HEXANE
26. 2-BUTANOL
27. ETHYL ACETATE
28. METHYL CYCLOPENTANE
29. 1,1,1-TRICHLOROETHANE
30. ISOBUTANOL
31. BENZENE
32. CYCLOHEXANE
33. 1,1,-DIMETHYL CYCLOPENTANE
34. 2-METHYLHEXANE
35. n-BUTANOL
36. 3-METHYLHEXANE
37. METHYLISOBUTANOATE
38. TRICHLOROETHENE
39. DIMETHYLCYCLOPENTANE
40. ISOOCTANE
41. n-HEPTANE
42. METHYLCYCLOHEXANE
43. METHYL BUTANOATE
44. 1,1,3- TRIMETHYLCLOPENTANE
45. PROPYLACETATE
46. ETHYL CLYCLOPENTANE
47. METHYLISOBUTYL KETONE
48. 1,2,4- TRIMETHYLCYCLOPENTANE
49. 1,2,3- TRIMETHYLCYCLOPENTANE
50. TOLUENE
51. 2,3,4-TRIMETHYLPENTANE
52. 2,3,3-TRIMETHLYPENTANE
53. ETHYLISOBUTANOATE
54. 3-ETHYL-2-METHYLPENTANE
55. 2-HEXANOL
56. 1,4, DIMETHYLCYCLOHEXANE
57. ETHYLMETHYLCYCLOPENTANE
58. 1,2,-DIMETHYLCYCLOHEXANE
59. PERCHLOROETHYLENE
60. ETHYLBUTANOATE
61. n-OCTANE
62. CHLOROBENZENE
63. 1,1,3-TRIMETHYLCYCLOHEXANE
64. ETHYLBENZENE
65. 1,2,4-TRIMETHLYCYCLOHEXANE
66. m+p-XYLENE
67. 1,3,5,7-CYCLOOCTATETRAENE
68. o-XYLENE
69. PROPYLBUTANOATE
70. n-NONANE
71. ETHYLTOLUENE
72. α-PINENE
73. TRIMETHYLBENZENE
74. DICHLOROBENZENE
75. 3-CARENE
76. n-DECANE
77. LIMONENE

FIGURE 7

GC/MS total ion Chromatogram
of raw Class II Landfill Gas.

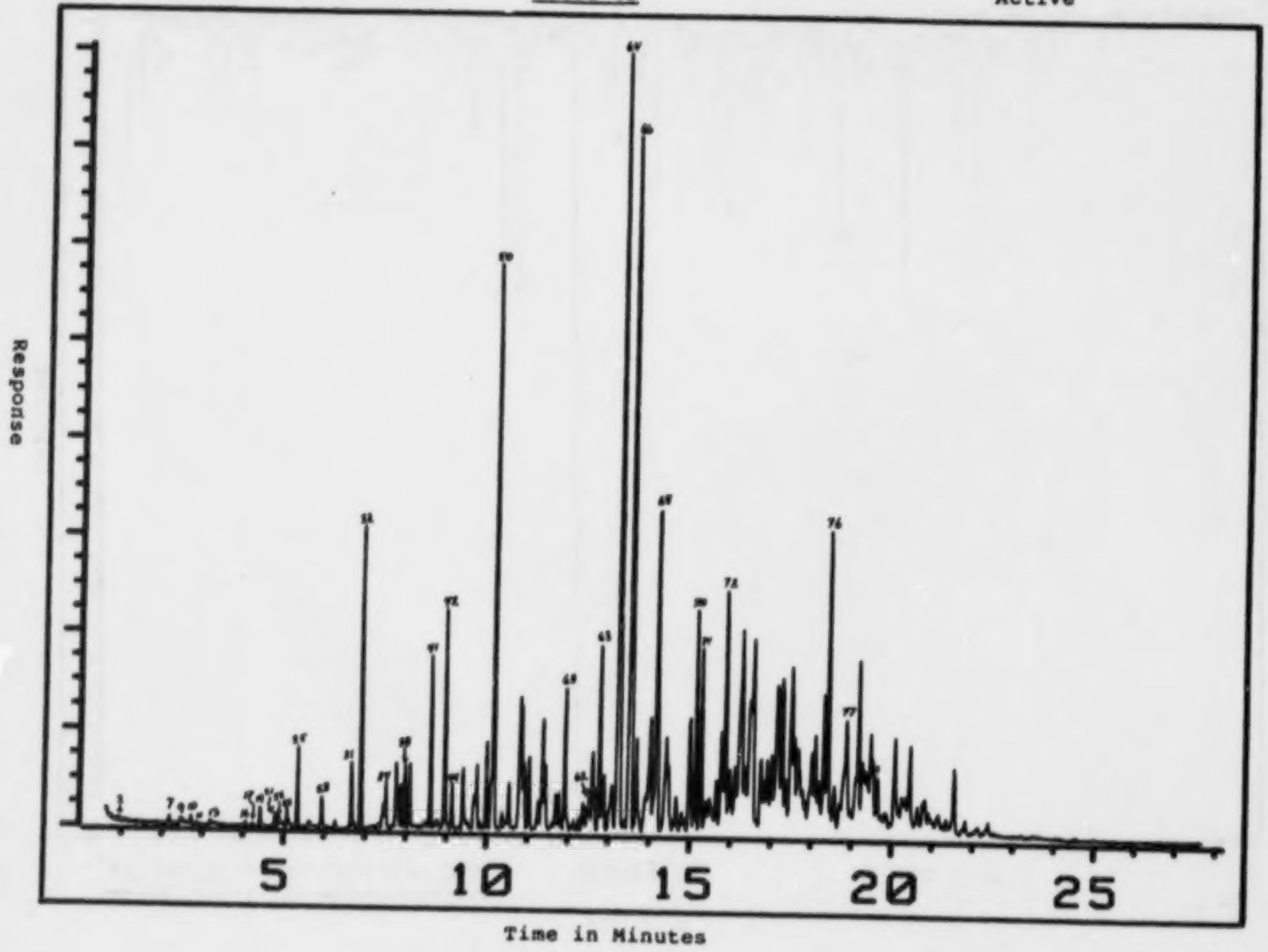


FIGURE 8

GC/MS total ion Chromatogram
of raw Class II Landfill Gas.

UPLAND .D

Closed 1979

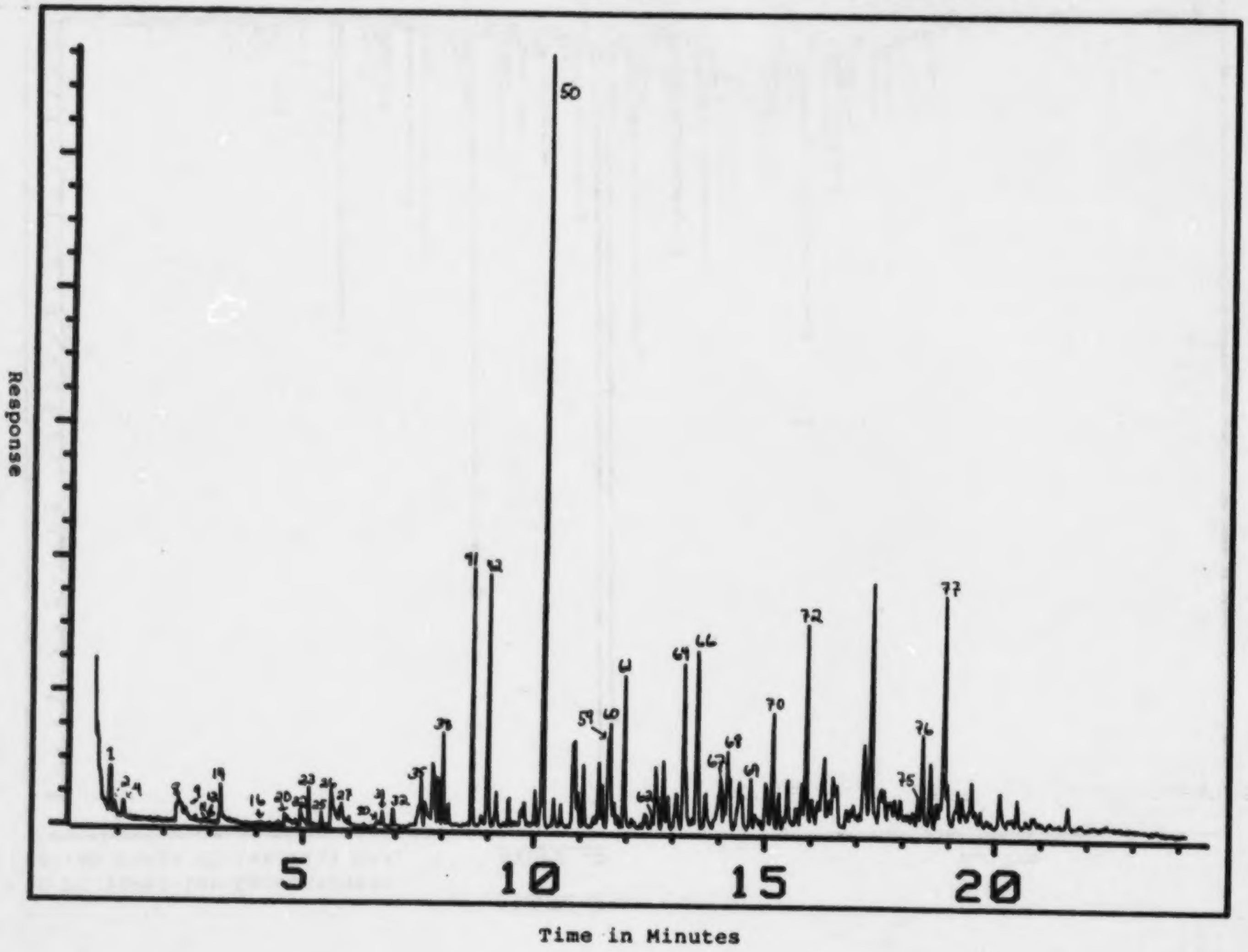
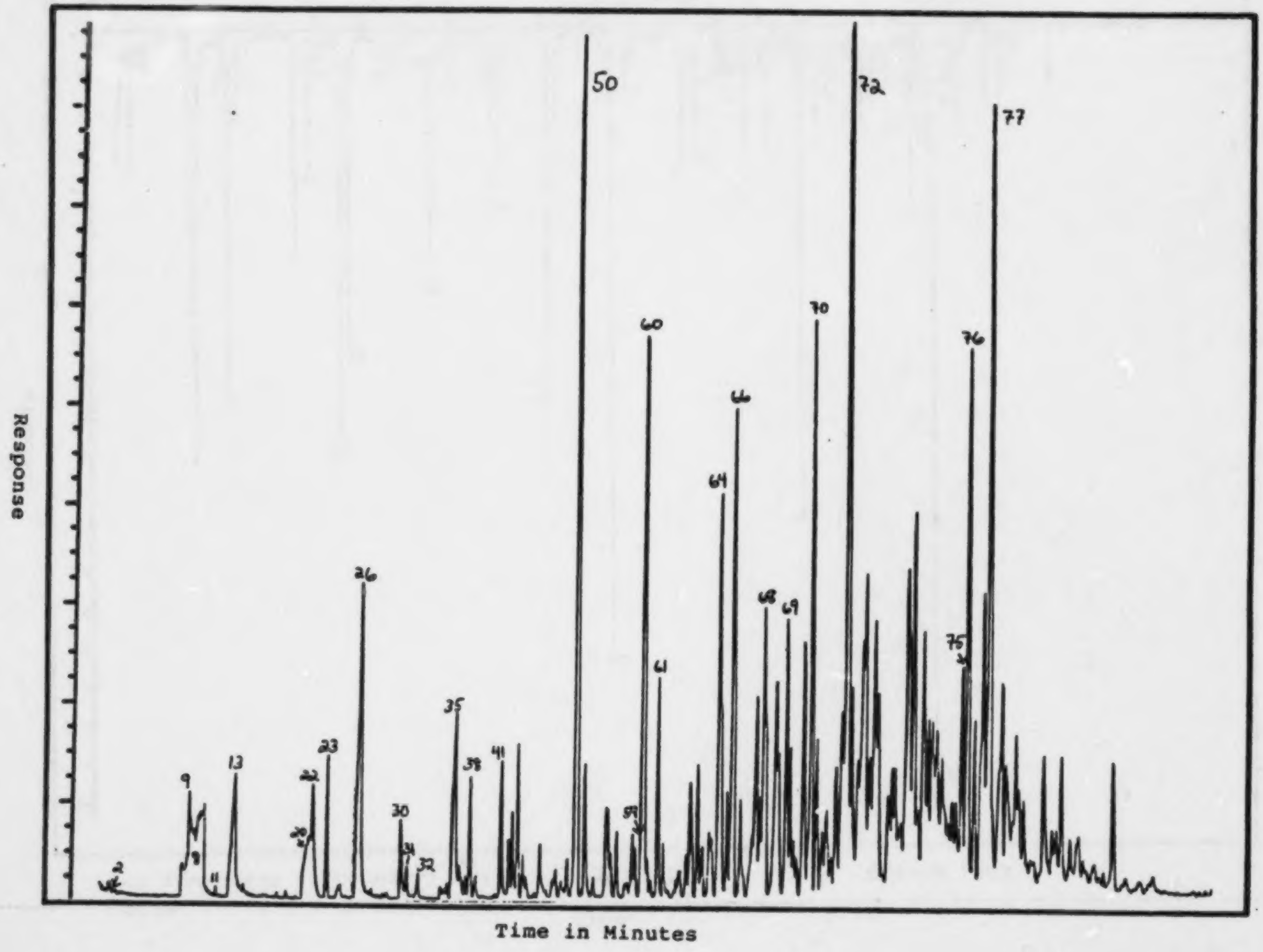


FIGURE 9

GC/MS total ion Chromatogram
of raw Class II Landfill Gas.

SCHOLL .D

Active



GC/MS total ion Chromatogram
of raw Class II Landfill Gas.

FIGURE 10

TOYON .D

Closed 1983

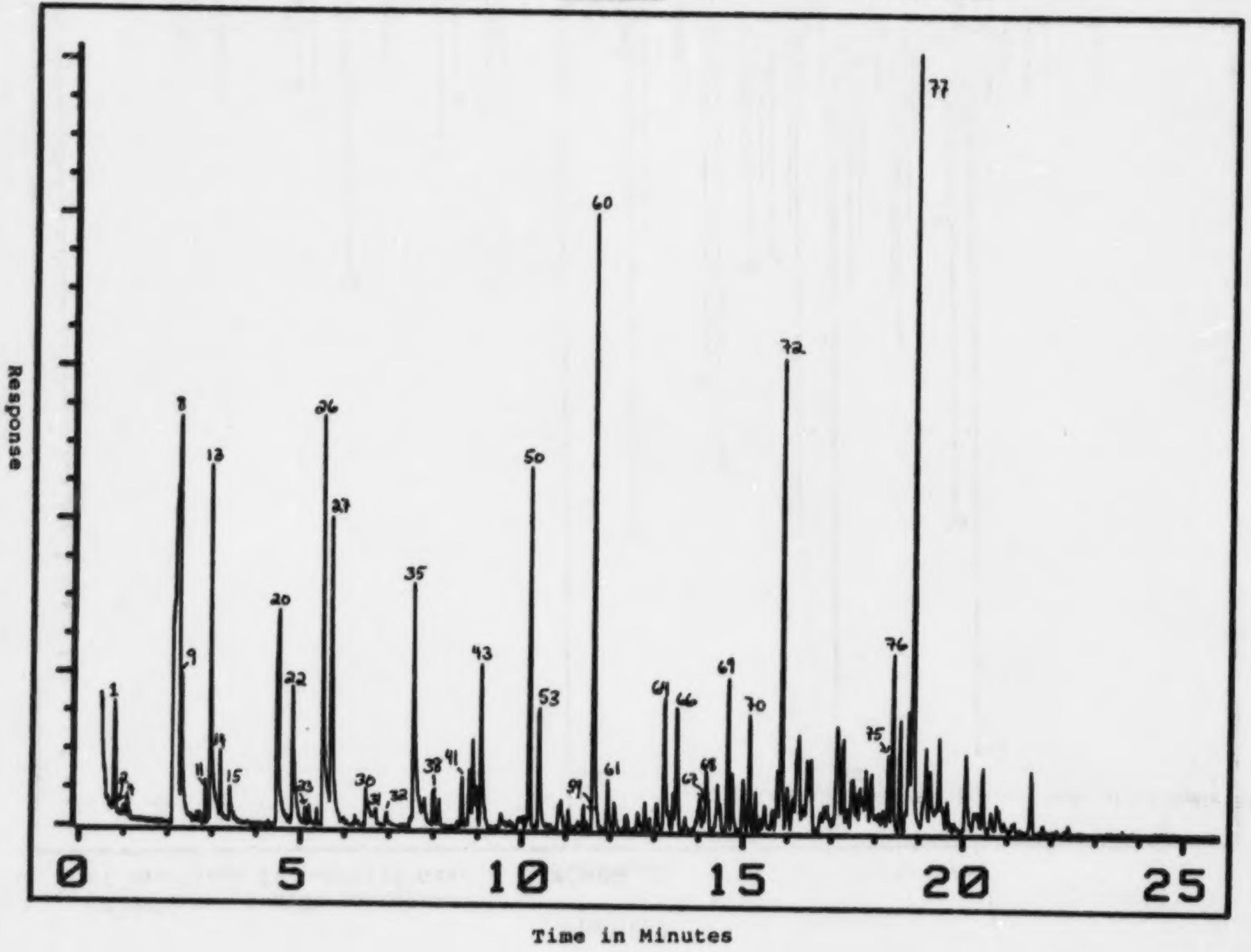


FIGURE 11

GC/MS total ion Chromatogram
of raw Class II Landfill Gas.

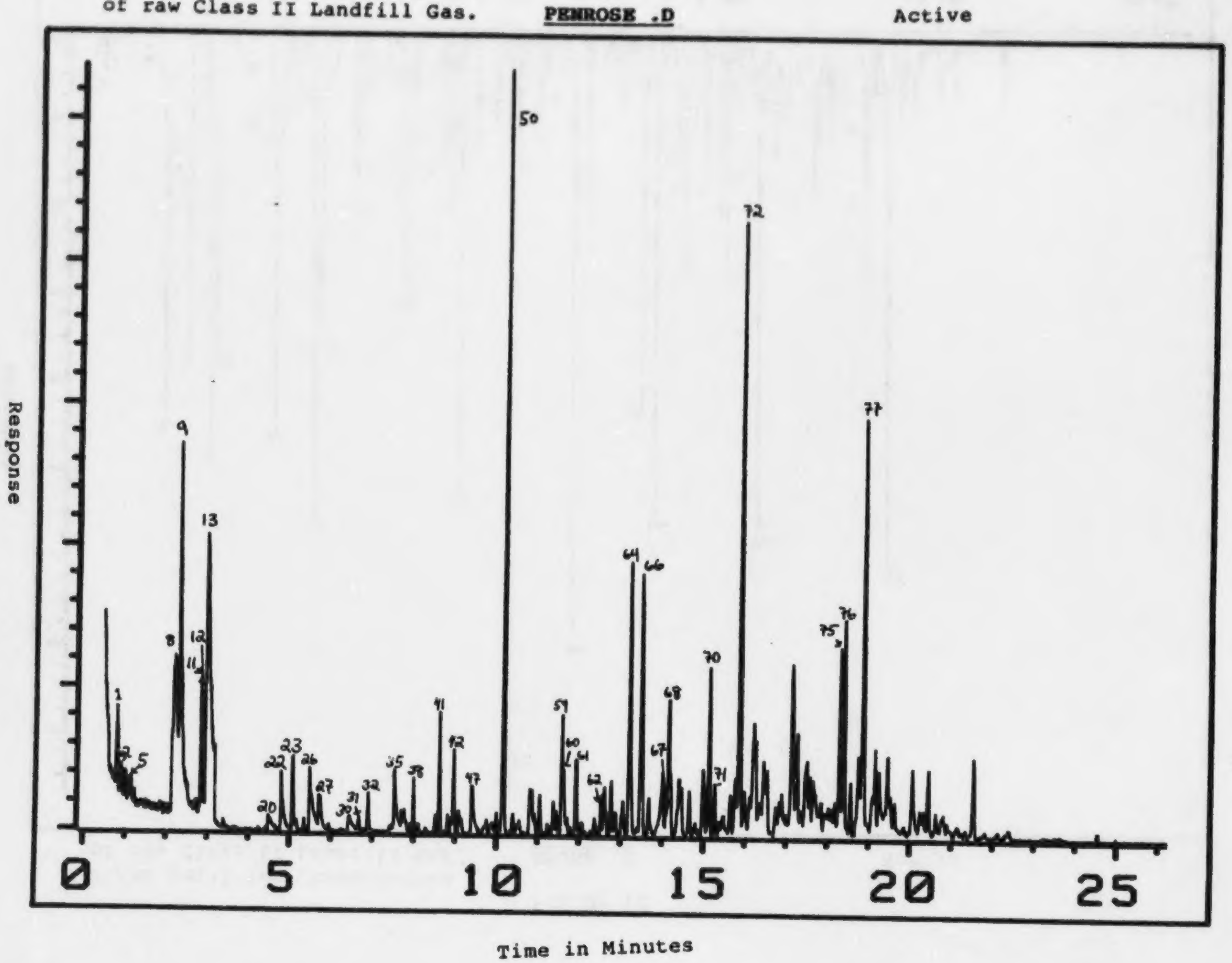
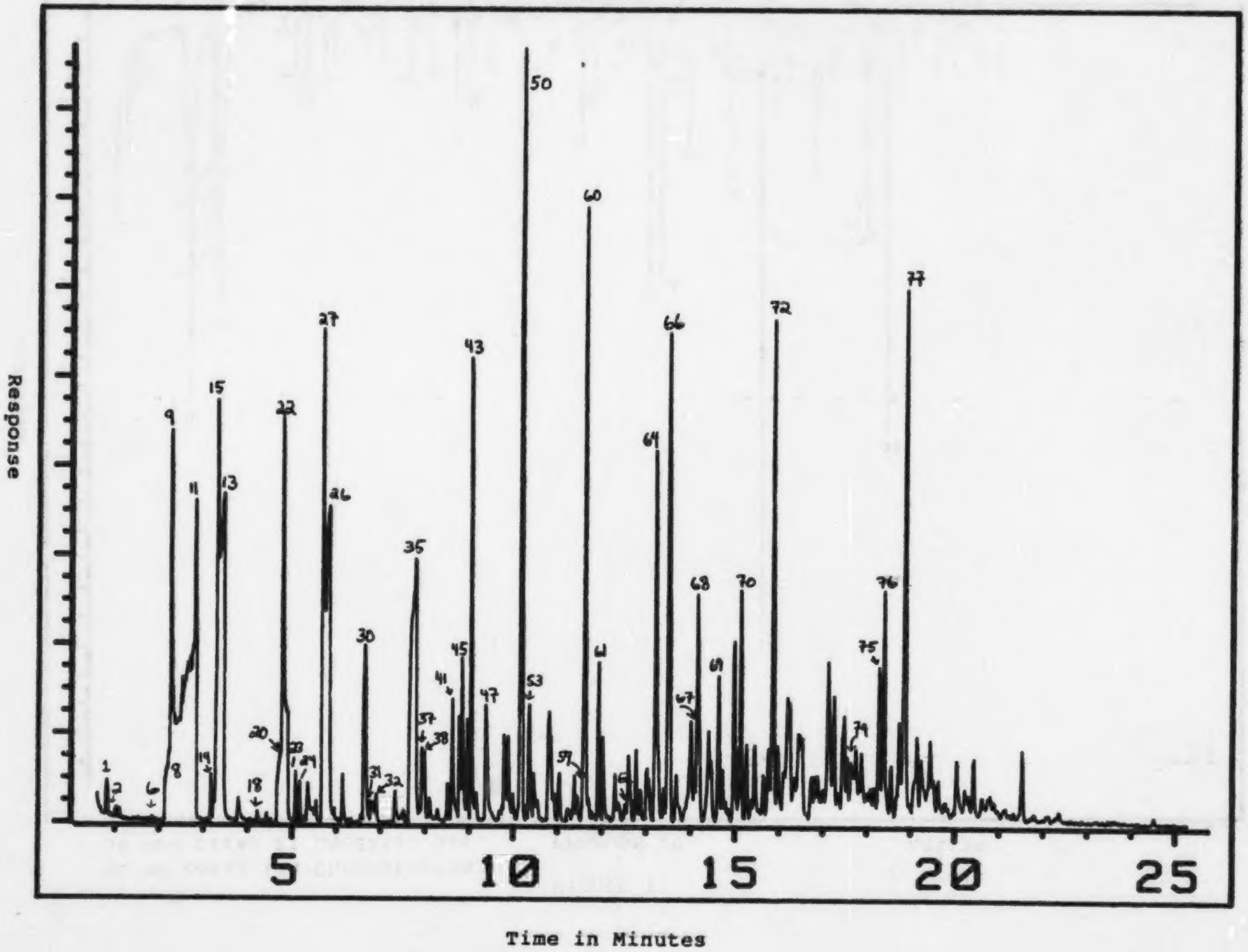


FIGURE 12

GC/MS total ion Chromatogram
of raw Class II Landfill Gas. **AZUSA .D** Active



Ambient Monitoring

An important aspect of this project was the evaluation of airborne transport of toxics off of the landfill sites. Five landfills were chosen as test cases for at least five days each of ambient monitoring. The most important compound for this phase of the study was vinyl chloride. The only possible source of vinyl chloride at the chosen locations was the landfill itself. All of the other compounds, benzene, toluene and various chlorinated organics, could have come from other sources. The results of the ambient monitoring program are given in Table VII.

Only one of the sites, Scholl Canyon, produced measurable 24-hour concentrations of vinyl chloride off-site. This occurred very early in the study. Our field personnel noticed that the landfill operator had a crew of three persons spending 8 hours each day filling cracks in the surface of the landfill face above our sampler. This activity started on the third day of our study and could have resulted in lower emissions.

The timing of this grant placed most of the ambient sampling in the winter months when relatively low ambient levels of toxics around landfills are experienced.. The highest concentrations of landfill emissions occur during summer months when there are long periods of nighttime drainage air movement. Most Southern California landfills are located in canyons where radiative ground and air cooling results in a layer of dense, cold surface air flowing downhill much like a river. The lack of a nighttime prevailing wind around landfill sites allows the drainage air to stagnate, resulting in relatively higher concentrations.

Meteorological Conditions

Mountaingate

There were five sampling days. Four of those days had clear skies during the daylight hours and most of the night. Low clouds developed during the early hours. The remaining day had a mild, warm Santa Ana condition with clear skies. The night was cool.

There was an average of about 9 hours of drainage conditions on each day of the study. Maximum temperatures ranged from 65°F to 77°F, while the minimum temperatures ranged from 53°F to 57°F. There was no rain.

Meteorological conditions were fair for the purposes of this study.

Upland

There were five sampling days. Three of the days had clear skies with early morning low clouds. Two of the days were completely cloudless.

There was an average of about 10 hours of drainage conditions on each day of the study. The maximum temperatures ranged from 54°F to 64°F, while the minimum temperatures ranged for 35°F to 45°F. There was 0.02 inch of precipitation on one day of the study.

Meteorological conditions ranged from fair to good for the purposes of this study.

Scholl Canyon

There were six sampling days. The first four days had clear skies during the daylight hours with low clouds developing during the early morning hours. The last two days were clear.

The drainage winds averaged 14 1/2 hours per day during the study. Maximum temperatures ranged from 76°F to 87°F, and the minimum temperatures ranged from 54°F to 57°F. There was no precipitation.

Meteorological conditions were good for the purposes of this study.

Calabasas

There were five sampling days. Three days had clear skies most of the day with early morning low clouds. The remaining two days were clear. Drainage winds averaged 12 hours each day. Maximum temperatures ranged from 65°F to 79°F, while minimum temperatures ranged from 40°F to 58°F. There was no precipitation.

Meteorological conditions were considered good for the purposes of this study.

Redlands

There were five sampling days with hot, clear days and warm clear nights. There were about 7 hours of drainage winds for each night of the study. Maximum temperatures ranged from 94°F to 101°F, while minimum temperatures ranged from 60°F to 74°F. There was no precipitation.

Meteorological conditions were considered fair to good for the purposes of this study.

TABLE VII

AMBIENT AIR SAMPLING

UPLAND LANDFILL

VINYL CHLORIDE (ppb v/v)

Date 1986	SITE EDDINGTON	 FERNANDO
2/29 - 3/1	<2	<2
3/1 - 3/2	<2	<2
3/2 - 3/3	*	*
3/5 - 3/6	<2	<2
3/6 - 3/7	<2	<2
3/7 - 3/8	*	*
4/2 - 4/3	*	<2
4/3 - 4/4	<2	<2
4/11 (1500-1800 hrs.)		<2

* No Sample

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
City of Redlands Landfill - August 27 to 28, 1985

Component	Alabama St. Site	Water Treatment Site
Methane	3260	5220
Vinyl Chloride	<2	<2
Chloroform	<0.30	0.44
1,2-Dichloroethane	<28	<28
1,1,1,-Trichloroethane	1.7	1.5
Carbon Tetrachloride	0.090	0.11
Trichloroethylene	0.41	0.22
Perchloroethylene	3.2	1.3
Benzene	1	3
Toluene	6	4

Laboratory No. 82415-6

Ref: 61V-29,42
TCH 21-2
SB 15-5

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
City of Redlands Landfill - August 28 to 29, 1985

Component	Alabama St. Site	Water Treatment Site
Methane	NA	NA
Vinyl Chloride	<2	<2
Chloroform	<0.25	<0.25
1,2-Dichloroethane	<28	<28
1,1,1,-Trichloroethane	2.1	2.6
Carbon Tetrachloride	0.10	0.11
Trichloroethylene	0.63	0.67
Perchloroethylene	4.7	4.6
Benzene	2	3
Toluene	6	7

Laboratory No. 82465-3

Ref: TCH21-10
61V-34,44

NA - Not Analyzed

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
City of Redlands Landfill - July 9, to July 10, 1985

Component	Alabama St. Site	Water Treatment Site
Methane	3300	NA
Vinyl Chloride	<2	<2
Chloroform	<0.25	NA
1,2-Dichloroethane	<28	NA
1,1,1-Trichloroethane	1.5	NA
Carbon Tetrachloride	0.050	NA
Trichloroethylene	0.070	NA
Perchloroethylene	2.1	NA
Benzene	3	NA
Toluene	4	NA

Laboratory No. 81915-10

Ref: 60V-66,72
SB13-107
TCH20-78

NA - Not analyzed, sample lost.

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
Laboratory Services Division
Landfill - Ambient Air Monitoring
(Concentrations in ppb , v/v)

Sampling Date and Site
City of Redlands Landfill - July 10, to July 11, 1985

Component	Alabama St. Site	Water Treatment Site
Methane	4600	4100
Vinyl Chloride	<2	<2
Chloroform	<0.25	<0.25
1,2-Dichloroethane	<28	<28
1,1,1-Trichloroethane	2.3	1.8
Carbon Tetrachloride	0.13	0.060
Trichloroethylene	<0.22	<0.22
Perchloroethylene	4.0	3.3
Benzene	3	3
Toluene	4	5

Laboratory No. 81925-4

Ref: 60V-69
TCH20-79

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
Calabasas Landfill, Feb. 28, to Mar.1, 1985

Component	Site 5	6	7	9
Methane	2420	2180	4680	2140
Vinyl Chloride	<2	<2	<2	<2
t-1,2-Dichloroethene	<35	<35	<35	<35
Chloroform	<0.70	<0.70	<0.70	<0.70
1,2-Dichloroethane	<23	<23	<23	<23
1,1,1-Trichloroethane	2.5	2.0	1.8	2.0
Carbon Tetrachloride	<0.10	<0.10	<0.10	<0.10
Trichloroethylene	<0.60	<0.60	<0.60	<0.60
Perchloroethylene	6.4	3.9	2.7	2.0
Benzene	2	3	4	3
Toluene	7	5	13	5

Laboratory No. 80605-14

Ref: FT10-2
SB11-117

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
Calabasas Landfill - Mar.12, to Mar.13, 1985

Component	Site 4	5	6	7	9
Methane	6350	3310	2710	2640	3310
Vinyl Chloride	<2	<2	<2	<2	<2
t-1,2-Dichloroethene	<11	<11	<11	<11	<11
Chloroform	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichloroethane	<7.0	<7.0	<7.0	<7.0	<7.0
1,1,1-Trichloroethane	2.6	2.2	2.1	1.1	3.2
Carbon Tetrachloride	0.10	0.10	0.10	0.10	0.10
Trichloroethylene	0.90	0.90	0.70	0.30	0.90
Perchloroethylene	9.7	11	10	2.6	7.0
Benzene	2	2	2	<2	<2
Toluene	6	5	3	<3	5

Laboratory No. 80725-12

Ref: 58V-67
SB13-62
FT9-7
RWE12-122

TABLE VII(Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
Calabasas Landfill - Mar. 13, to Mar. 14, 1985

Component	Site 4	5	6	7	9
Methane	4340	No Sample	1980	2040	6960
Vinyl Chloride	<2		<2	<2	<2
t-1,2-Dichloroethene	<10		<10	<10	<10
Chloroform	<0.2		<0.2	<0.2	<0.2
1,2-Dichloroethane	<7		<7	<7	<7
1,1,1-Trichloroethane	1.5		1.9	1.5	1.2
Carbon Tetrachloride	0.1		0.1	0.1	0.1
Trichloroethylene	0.3		0.5	0.3	0.3
Perchloroethylene	4.4		8.7	5.1	1.8
Benzene	<2		<2	<2	<2
Toluene	<3		<3	<3	<3

Laboratory No. 80745-1

Ref: SB13-65
FT12-9
RWE12-128
58V-72

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
Calabasas Landfill, Mar. 19, to Mar. 20, 1985

Component	Site 4	5	6	7	9
Methane	4260	2570	2250	2380	4380
Vinyl Chloride	<2	<2	<2	<2	<2
t-1,2-Dichloroethene	<12	<12	<12	<12	<12
Chloroform	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichloroethane	<8	<8	<8	<9	<9
1,1,1-Trichloroethane	2.1	2.0	2.3	2.9	3.0
Carbon Tetrachloride	0.1	0.1	0.1	0.1	0.1
Trichloroethylene	<0.2	0.4	0.4	0.5	0.6
Perchloroethylene	3.1	3.3	3.6	8.1	8.1
Benzene	<4	<4	<4	7	4
Toluene	<6	<6	<6	<6	<6

Laboratory No. 80805-1

Ref: SB12-59
FT10-10
58V-88
RWE12-140

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Laboratory Services Division

Landfill - Ambient Air Monitoring

(Concentrations in ppb , v/v)

Sampling Date and Site
Calabasas Landfill, April 8, to April 9, 1985

Component	Site 4	5	6	7	9
Methane	6030	2590	2330	No Sample	3810
Vinyl Chloride	<2	<2	<2		<2
t-1,2-Dichloroethene	<2.4	<2.4	<2.4		<2.4
Chloroform	<0.056	<0.056	<0.056		<0.056
1,2-Dichloroethane	<2.1	<2.1	<2.1		<2.1
1,1,1-Trichloroethane	1.6	1.8	1.6		2.8
Carbon Tetrachloride	0.078	0.079	0.081		0.081
Trichloroethylene	0.19	0.16	0.20		0.28
Perchloroethylene	1.4	2.2	1.9		4.1
Benzene	<3	<3	<3		<3
Toluene	<5	<5	<5		<5

Laboratory No. 80995-6

Ref: 58V-109
MP10-37
SB12-75

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

MOUNTAIN GATE, LANDFILL

VINYL CHLORIDE (ppb, $^{v}/v$)

Date 1984	Site 1	 2	 3	 4
4/16 -4/17	<2	<2	<2	<2
4/23 -4/24	<2	<2	<2	<2
4/24 -4/25	<2	<2	<2	<2
5/1 - 5/2	<2	<2	<2	<2
5/2 - 5/3	<2	<2	<2	<2
5/3 - 5/4	<2	<2	<2	<2

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

MOUNTAIN GATE LANDFILL
BENZENE & TOLUENE

(Concentration in ppb, $^{v}/v$)

	BENZENE				**TOLUENE**			
Date 1984	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 1**	**Site 2**	**Site 3**	**Site 4**
4/23 - 4/24	<5	<5	<5	<5	<10	<10	<10	<10
4/24 - 4/25	<5	<5	<5	<5	<10	<10	<10	<10
5/1 - 5/2	<5	<5	<5	<5	<10	<10	<10	<10
5/3 - 5/4	<5	<5	<5	<5	<10	<10	<10	<10

Sample from 5/2 - 5/3 not analyzed.

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

MOUNTAIN GATE LANDFILL

SELECTED CHLORINATED HYDROCARBONS

(Concentration in ppb, $^{v}/v$)

Date 1984	Site	Chloroform	Carbon Tetra-chloride	1,1,1-Tri-chloroethane	Triochloro-ethylene	1,2 Dichloro-ethane	Perchloro-ethyle
4/16 - 4/17	1	<1.6	<0.20	<0.67	<1.0	<15	1.3
	2	<1.6	<0.20	1.6	<1.0	<15	3.4
	3	<1.6	<0.20	1.0	<1.0	<15	2.5
	4	<1.6	<0.20	<0.67	<1.0	<15	1.6
4/23 - 4/24	1	<1.6	<0.20	<0.67	<1.0	NA	0.70
	2	<1.6	<0.20	0.67	<1.0	NA	1.4
	3	<1.6	<0.20	0.67	<1.0	NA	0.70
	4	<1.6	<0.20	0.67	<1.0	NA	0.70
4/24 - 4/25	1	<1.6	<0.20	<0.67	<1.0	NA	0.70
	2	<1.6	<0.20	<0.67	<1.0	NA	1.1
	3	<1.6	<0.20	<0.67	<1.0	NA	0.70
	4	<1.6	<0.20	<0.67	<1.0	NA	0.70

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

MOUNTAIN GATE LANDFILL

SELECTED CHLORINATED HYDROCARBONS

(Concentration in ppb, $^{v}/v$)

Date 1984	Site	Chloroform	Carbon tetra-chloride	1,1,1-Tri-chloroethane	Trichloro-ethane	1,2-Dichloro-ethane	Perchloro-ethylene
5/1/ - 5/2	1	<1.6	<1.3	<3.5	<9.0	<85	<2.3
	2	<1.6	<1.3	<3.5	<9.0	<85	<2.3
	3	<1.6	<1.3	<3.5	<9.0	<85	<2.3
	4	<1.6	<1.3	<3.5	<9.0	<85	<2.3
5/3 - 5/4	1	<1.6	0.22	4.8	<1.0	<15	1.0
	2	<1.6	<0.20	<0.67	<1.0	<15	0.67
	3	<1.6	<0.20	14	<1.0	<15	2.5
	4	<1.6	<0.20	1.8	<1.0	<15	0.67

Sample from 5/2 - 5/3 not analyzed

TABLE VII (Cont.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

SCHOLL CANYON LANDFILL VICINITY

Laboratory Results for Toxics Monitoring in Ambient Air from August 29 through October 19, 1984 for:

Vinyl Chloride

and from October 9 through October 19, 1984 for:

t-1,2 dichloroethene
Chloroform
1,2 dichloroethane
1,1,1-trichloroethane
Carbon Tetrachloride
Trichloroethylene
Perchloroethene

Benzene
Toluene

Methane

Ref: LN82624-15
LN82854-2
LN82864-1

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

SCHOLL CANYON LANDFILL VICINITY

VINYL CHLORIDE (PPB, $^v/v$)

Date 1986	Site 1	2
8/28 - 8/29	<2	3
8/29 - 8/30	2	<2
8/30 - 8/31	2	<2
9/4 - 9/5	3	<2
9/5 - 9/6	No Sample	8
9/6 - 9/7	<2	4

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

SCHOLL CANYON LANDFILL VICINITY

VINYL CHLORIDE (ppb, $^{v}/v$)

Date 1984	Site 1	 2	 3	 4
9/17 - 9/18	2	3	<2	
9/18 - 9/19	2	-	<2	
9/19 - 9/20	2	2	2	
9/20 - 9/21	<2	<2	<2	
9/25 - 9/26	<2	3	<2	<2
9/26 - 9/27	<2	<2	<2	<2
9/27 - 9/28	3	<2	<2	<2
10/2 - 10/3	<2	<2	2	<2
10/3 - 10/4	<2	<2	<2	<2
10/4 - 10/5	<2	<2	<2	
10/8 - 10/9	<2	<2	<2	

TABLE VII (Cont.)

AMBIENT AIR SAMPLING

SCHOLL CANYON LANDFILL

VINYL CHLORIDE

DATE 1984	1	2	3	4	Sch. Roof Park	Site C	Site 1 Direct	5
10/9-10/10	3		<2		<2			
10/10-10/11	<2	<2	<2	<2		<2	<2	
10/17-10/18	<2	<2	<2	<2				<2

TABLE VII (Cont.)

SCHOLL CANYON LANDFILL VICINITY

TOXICS MONITORING
10-9 to 10-10
1984

Sample	Site 1 Bag #215	Park Roof Bag #212	Site 3 Bag #230
Methane	63.6	21.4	3.07
Benzene	3	<2	3
Toluene	12	<2	6
Vinyl Chloride	3	<2	<2
t-1,2 dichloroethene	<25	<25	<25
Chloroform	<0.50	<0.50	<0.50
1,2 dichloroethane	<20	<20	<20
1,1,1-trichloroethane	2.0	1.9	1.9
Carbon Tetrachloride	0.070	0.10	0.10
Trichloroethylene	<0.50	<0.50	<0.50
Perchloroethylene	1.5	1.4	1.4

NOTE: Methane is reported in ppm, and all other components in ppb.

Ref. TCH-18-52
SB-11-80
54V-75

TABLE VII (Cont.)

SCHOLL CANYON LANDFILL VICINITY

TOXICS MONITORING

10-10-to 10-11
1984

Sample	Site 1 #206	Site 2 #202	Site 3 #208
Methane	7.86	2.09	2.21
Benzene	<2	<2	<2
Toluene	17	<2	<2
Vinyl Chloride	<2	<2	<2
t-1,2 dichloroethene	<25	<25	<25
1,2-dichloroethane	<20	<20	<20
Chloroform	<0.50	<0.50	<0.50
1,1,1-trichloroethane	1.2	3.2	1.6
Carbon Tetrachloride	0.060	0.11	0.10
Trichloroethylene	0.26	0.41	<0.45
Perchloroethylene	1.8	3.3	1.3

NOTE: Methane is reported in ppm, and all other components in ppb.

Ref: SB-12-10, 16
TCH-18-84
54V-85

TABLE VII (Cont.)

SCHOLL CANYON LANDFILL VICINITY

TOXICS MONITORING

10-10 to 10-11
1984

Sample	Site 4 #214	Site C #157	Site 1 Directional #199
Methane	1.93	2.40	14.8
Benzene	<2	<2	<2
Toluene	<2	11	<2
Vinyl Chloride	<2	<2	<2
t-1,2 dichloroethene	<25	<25	<25
Chloroform	<0.50	<0.50	<0.50
1,2 dichloroethane	<20	<20	<20
1,1,1-trichloroethane	1.5	4.8	1.6
Carbon Tetrachloride	0.10	0.37	0.08
Trichloroethylene	<0.45	0.97	<0.45
Perchloroethylene	1.4	4.2	1.0

NOTE: Methane is reported in ppm, and all other components in ppb.

Ref: SB-11-82
TCH-18-55
54V-76

TABLE VII (Cont.)

SCHOLL CANYON LANDFILL VICINITY

TOXICS MONITORING
10-17 to 10-18
1984

Sample	**Site 1** **Bag #228**	**Site 2** **Bag #187**	**Site 3** **Bag #230**	**Site 4** **Bag #212**	**Site 5** **Bag #137**
Methane	13.1	15.1	6.71	2.47	2.12
Benzene	<2	<2	<2	<2	4
Toluene	8	10	<2	8	8
Vinyl Chloride	<2	<2	<2	<2	<2
t-1,2 dichloroethene	<35	<35	<35	<35	<35
Chloroform	<0.60	<0.60	<0.60	<0.60	<0.60
1,2 dichloroethane	<27	<27	<27	<27	<27
1,1,1-trichloroethane	2.5	3.8	0.95	1.2	4.2
Carbon Tetrachloride	0.10	0.11	0.07	0.11	0.07
Trichloroethylene	<0.55	<0.55	<0.55	<0.55	<0.55
Perchloroethylene	1.8	1.7	0.71	0.77	2.4

NOTE: Methane is reported in ppm, and all other components in ppb.

Ref: SB-12-10,16
TCH-18-84
54V-85

TABLE VII (Cont.)

SCHOLL CANYON LANDFILL VICINITY

TOXICS MONITORING
10-18 to 10-19
1984

Sample	**Site 1** **Bag #215**	**Site 2** **Bag #219**	**Site 3** **Bag #210**	**Site 4** **Bag #221**	**Site 5** **Bag #158**
Methane	56.0	22.1	9.45	3.08	2.45
Benzene	3	2	2	3	84
Toluene	14	10	7	7	260
Vinyl Chloride	<2	<2	<2	<2	<2
t-1,2 dichloroethene	<20	<20	<20	<20	<20
Chloroform	<0.35	<0.35	<0.35	<0.35	<0.35
1,2 dichloroethane	<13	<13	<13	<13	<13
1,1,1-trichloroethane	6.0	3.0	2.7	2.1	1.7
Carbon Tetrachloride	0.16	0.11	0.10	0.08	0.08
Trichloroethylene	0.62	<0.35	<0.35	<0.35	<0.35
Perchloroethylene	3.6	1.8	1.6	1.3	1.2

NOTE: Methane is reported in ppm, and all other components in ppb.

Sampling site 5 appears to have been contaminated by a solvent. Benzene and toluene concentrations were much higher than could possibly be expected in ambient air. Other components in that sample are of normal concentrations.

Ref: SB-11-92
SB-12-13
TCH-18-90
54V-85

Surrogates

Whenever excavation is done at a landfill, the District requires monitoring of the ambient air for toxic compounds which have been detected in the raw landfill gas. In almost every case, the contractor has wanted to use monitoring of methane as a surrogate for the toxics. We are not in favor of this approach.

Use of a methane surrogate is based on the assumption that the composition of landfill gas is uniform throughout the landfill. This simply is not true. In Table V, CH_4/VC ratios have been included to demonstrate the variability of landfill gas composition. The range of values for that ratio within one landfill often exceeds an order of magnitude. In the appropriate circumstances, methane may be used to indicate the presence of subsurface gas migration. Once migration is detected, further analysis is required to determine the presence of toxics.

It is necessary to measure the specific toxic component of concern rather than a surrogate like methane. As an example we have noted the existence of pockets of sulfur dioxide in drilling at McColl and excavation at Kellogg Terrace. The former is a toxic site which is being studied for remedial action. One drill site produced SO_2 concentrations up to 30,000 ppm a foot away from the excavated dirt, while a drill site a few tens of meters away produced no SO_2.

In a similar fashion Kellogg Terrace, a small landfill near a residential area, was excavated in 1981. There were no odor complaints prior to excavation, but some SO_2 was found in site tests. Continuous SO_2 monitors were placed around the site. Despite careful excavation on small faces, a pocket of SO_2 was breached that caused the continuous monitor to go off-scale at 0.5 ppm for 15 minutes next to some homes about 400 yards away from the excavation.

Origins of Toxics

Since we have established that significant amounts of toxics exist in Class II landfills, we must ask ourselves where these materials originate. (This information is essential, since the ultimate solution to a problem requires detailed knowledge of not only that a problem exists, but also how it happened.)

Toxics can come to exist in California's Class II landfills in only two ways: 1) illegal disposal of the toxic compound, or 2) production of the toxic in the landfill by chemical reaction or by biological action.

1. Illegal dumping can be separated into two main categories. The first is the intentional disposal of quantities of toxic waste by an industrial producer or consumer with or without the knowledge of the landfill operator.

   The second is the inadvertent disposal of toxics by homeowners and small businessmen. They can hardly be blamed for this since most are not aware of restrictions placed on what they can put into their household trash or the dumpster in back of their business. Even if they were aware of the restrictions there is no practical mechanism for the generator of small amounts of toxic waste to get it to a Class I site.

2. Production of toxics in the landfill can occur by chemical reactions or the co-metabolism of toxics by microorganisms[2]. Perchloroethylene and trichloroethane are readily converted into vinyl chloride and a wide variety of other similar compounds by microorganisms[3].

   Enzymes produced by microorganisms to consume hydrocarbons also happen to dehalogenate many halogenated organics[2]. While this process, carried to completion, would detoxify a landfill relative to more highly halogenated organics, it produces some toxics such as vinyl chloride and vinylidene chloride during the process.

   The relatively high concentrations of vinyl chloride we have found during this study lead us to believe that the rate of biodehalogenation of vinyl chloride may proceed at a rate significantly slower than the rates of the reactions that produce it. This was demonstrated in one study of biodehalogenation in swamp muck[3].

   The near future will shed more light on the fate of chlorinated organics in landfills as other groups study the mechanisms and organisms involved.

Gas Migration

Case I

In 1984, at BKK Class I landfill in West Covina, there was an incident of fresh gas migration. This was apparently caused by a lowered water table opening a pathway through a sandstone layer. Methane was detected in enclosed spaces in homes at concentration approaching 1%.

A sample of migrating gas was taken from a well outside the periphery of the landfill. Another sample was taken from under the kitchen sink of a nearby house, approximately 200 yards away from the periphery of the landfill. The samples were analyzed for methane and chlorinated hydrocarbons. The results of analysis are given in Table VIII. The last column in the table is the ratio of the concentration found under the kitchen sink to the concentration found in the well. It can be noted that the heavier compounds are depleted more rapidly than the lighter compounds. A plot of relative concentration vs. boiling point is given in Figure 13.

The line through the points is a regression in the form $\log(y) = CX + D$ in which $C = -1.37 \times 10^{-2}$ and $D = -3.9$. This relationship appears good for chlorinated hydrocarbons, but the constants could be expected to be different for other types of organic compounds.

It is worth noting that this was a case of new gas migration, and that it probably had not been going on long enough for steady state conditions to be achieved.

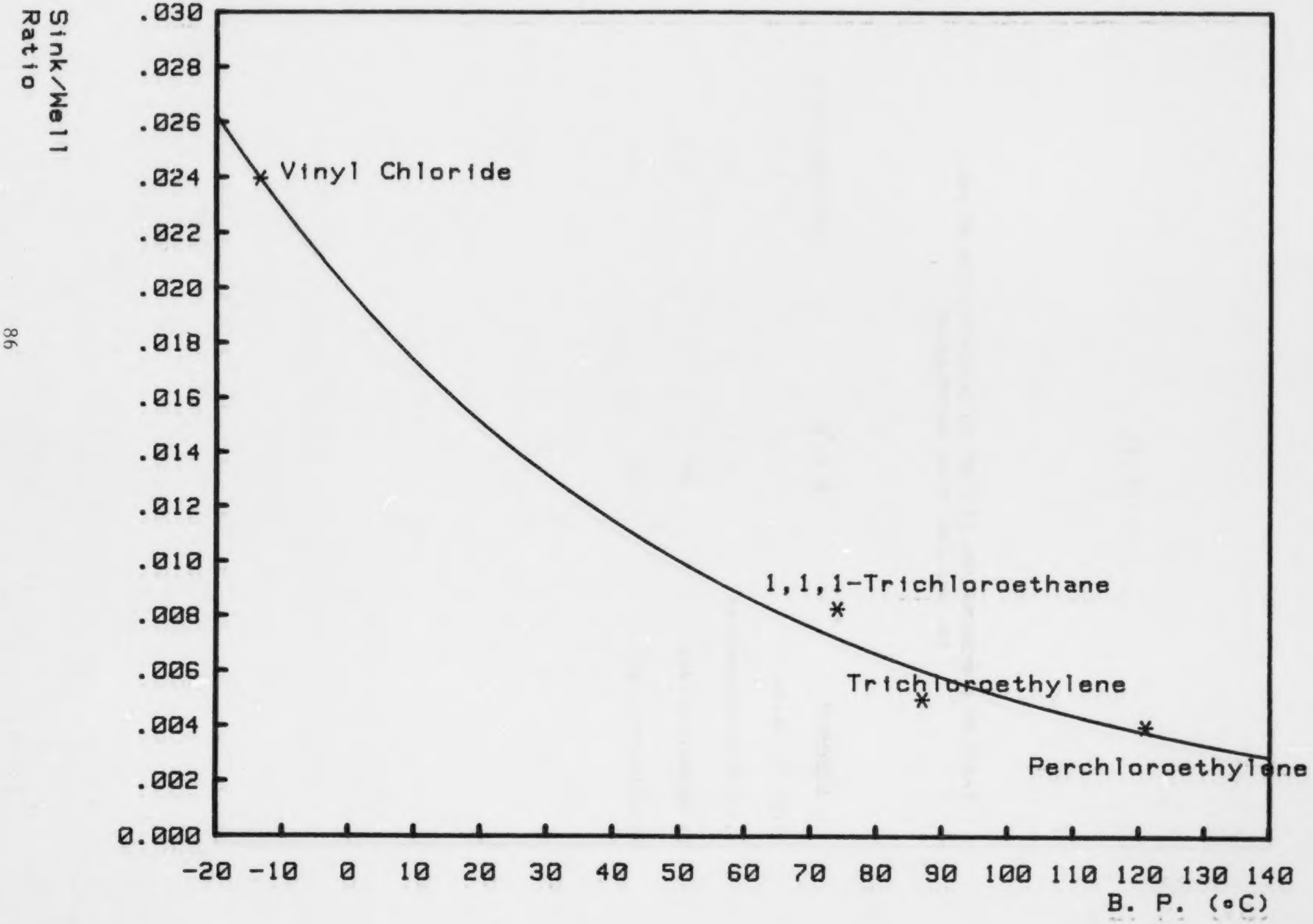
TABLE VIII

RATIO OF CONCENTRATION AT SINK TO CONCENTRATION AT WELL VS. BOILING POINT TEMPERATURE

Compound	B.P.°C.	Sink/Well Ratio
Vinyl Chloride	-13.4	.024
1,1,1-Trichloroethane	74.1	.0083
Trichloroethylene	87	.005
Perchloroethylene	121	.004

FIGURE 13

Chlorinated Hydrocarbon Gas Migration at BKK



Case II

At Operating Industries landfill, a Class II site in Monterey Park, landfill gas has been migrating off site for years.

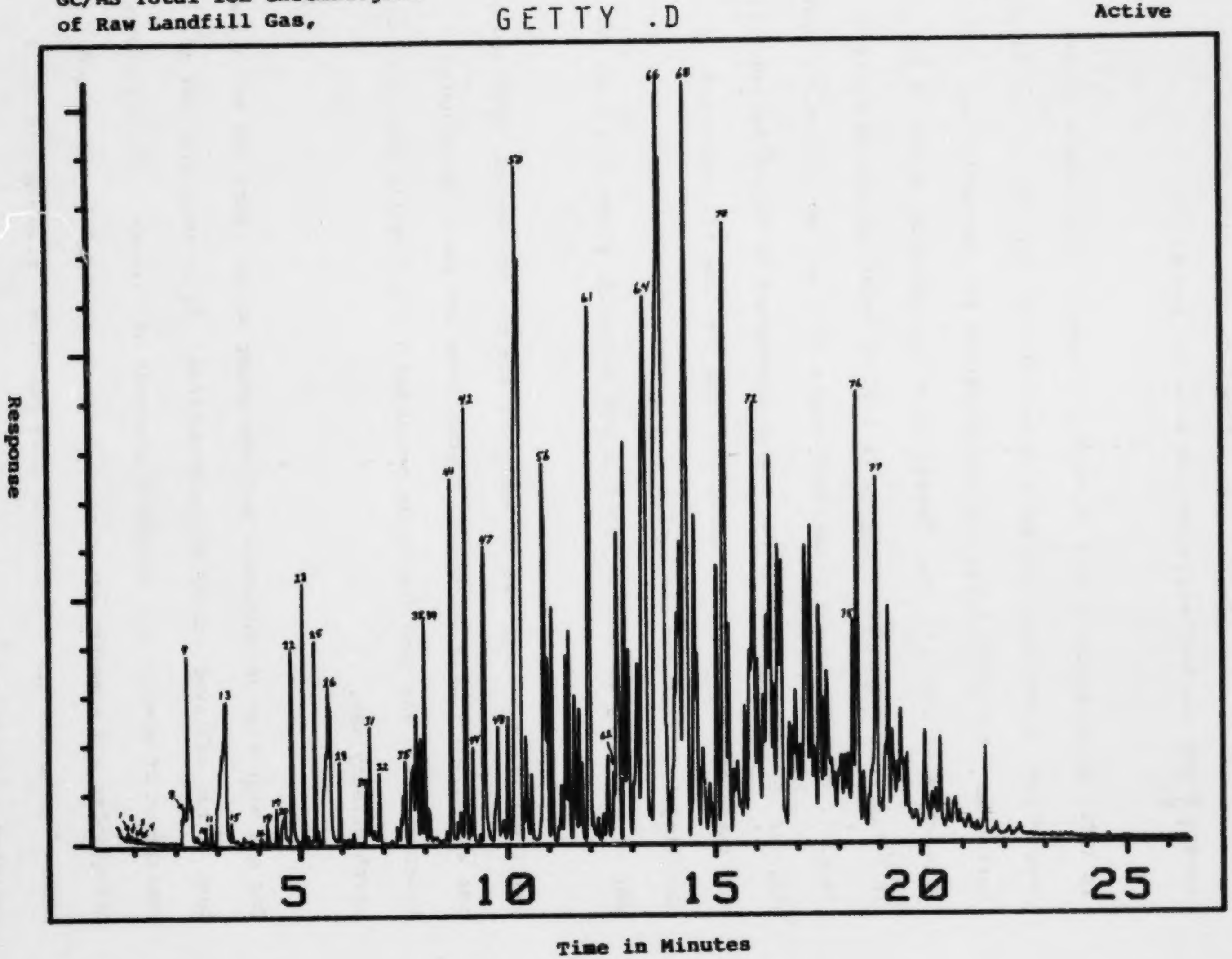
In 1986, we conducted a test to determine qualitative changes in gas composition as the landfill gas migrates through soil beyond the landfill perimeter. The GC/MS total ion chromatograms for the series are given in Figures 14 through 17. The identities of the numbered compounds are given in Table VI. Figure 14, Getty.D, is a GC/MS total ion chromatogram of raw landfill gas taken as an integrated sample from the gas collection system. Figures 15 - 17 are GC/MS total ion chromatograms of migrating landfill gas taken at increasing distances out from the landfill perimeter. Sampling locations for the series of migration samples can be seen on a map of Operating Industries landfill and vicinity, given in Figure 18.

The first organic compounds to disappear are the oxygenates, followed by the aromatics, sulfur compounds, hydrocarbons and polar chlorinated hydrocarbons. The last compounds remaining are the cyclic saturates and perchloroethylene.

The gas migration in this case has been going on for years and we assume that it has achieved steady state conditions. It is possible that the separation of some of the compounds proceeds as follows: The oxygenates, being polar and somewhat water soluble are dissolved into the ground water. Aromatics are attracted to clay particles (i.e. Bentone 34, a modified bentonite clay is an excellent column material for retaining

FIGURE 14

GC/MS Total ion Chromatogram
of Raw Landfill Gas,



GC/MS Total ion Chromatogram
of Migrating Landfill Gas from
Perimeter Well

FIGURE 15

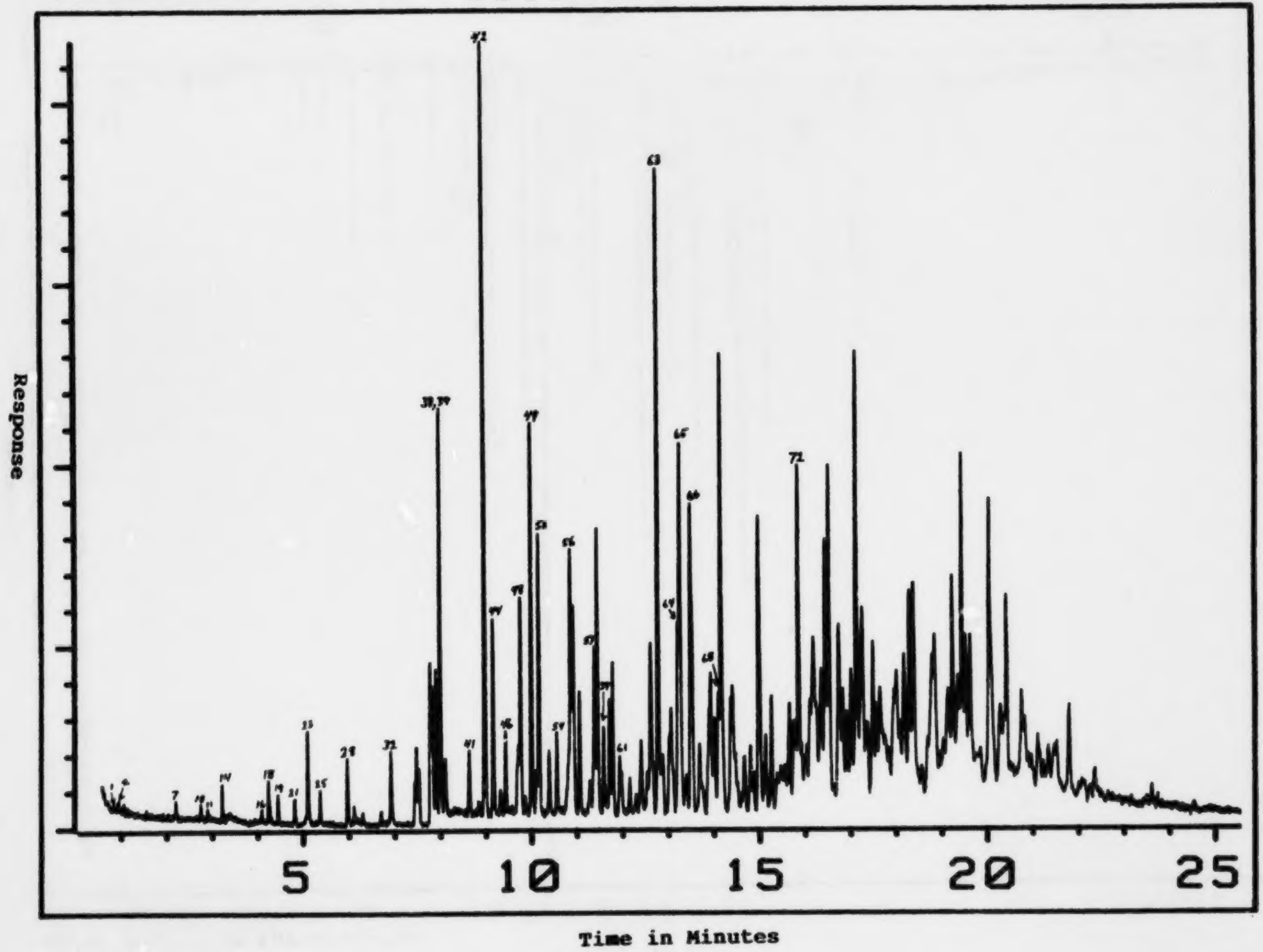


FIGURE 16

GC/MS Total ion Chromatogram
of Migrating Landfill Gas

SAMPLE #2. D

Off Site

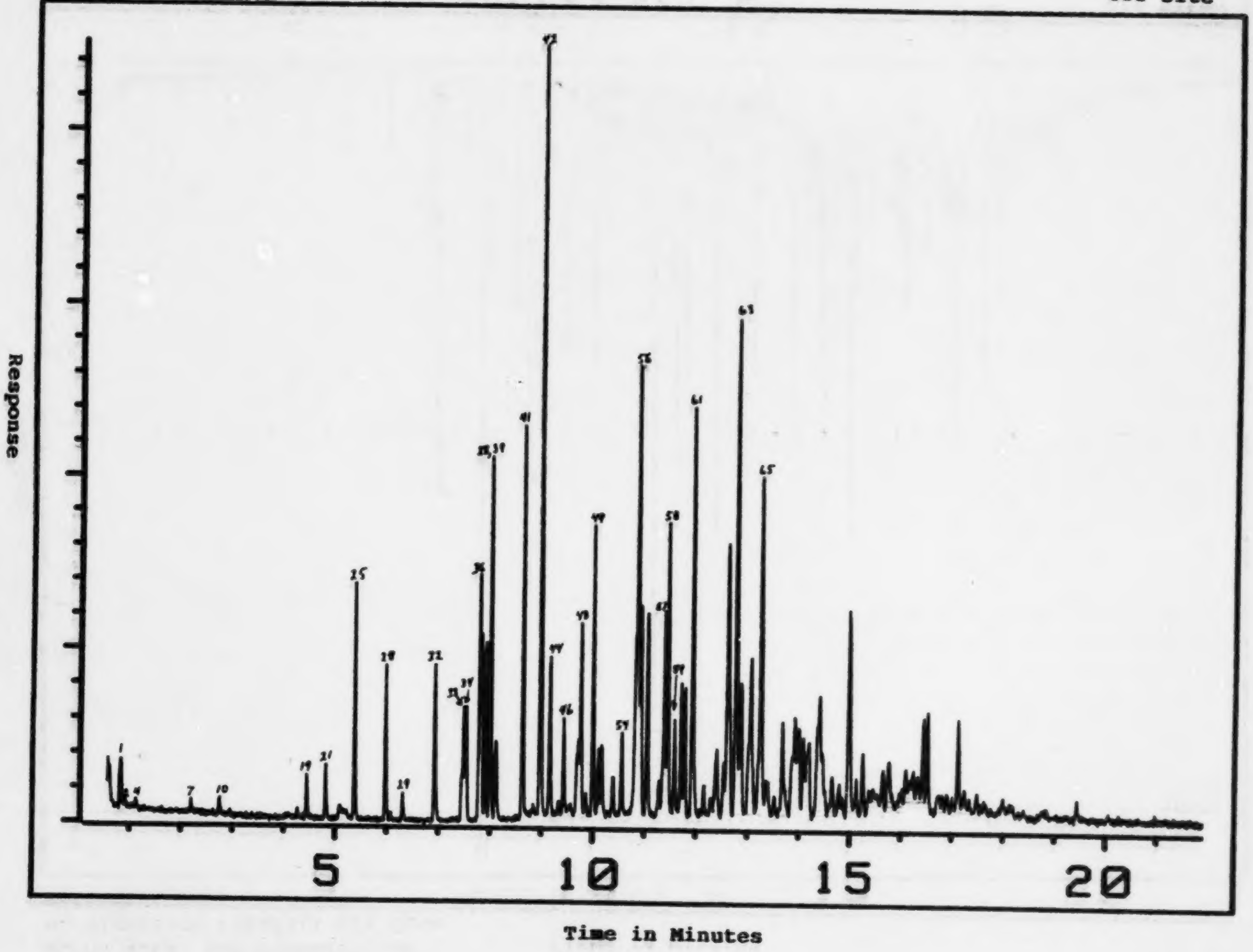


FIGURE 17

GC/MS Total ion Chromatogram
of Migrating Landfill Gas,

SAMPLE #3.D

Off Site

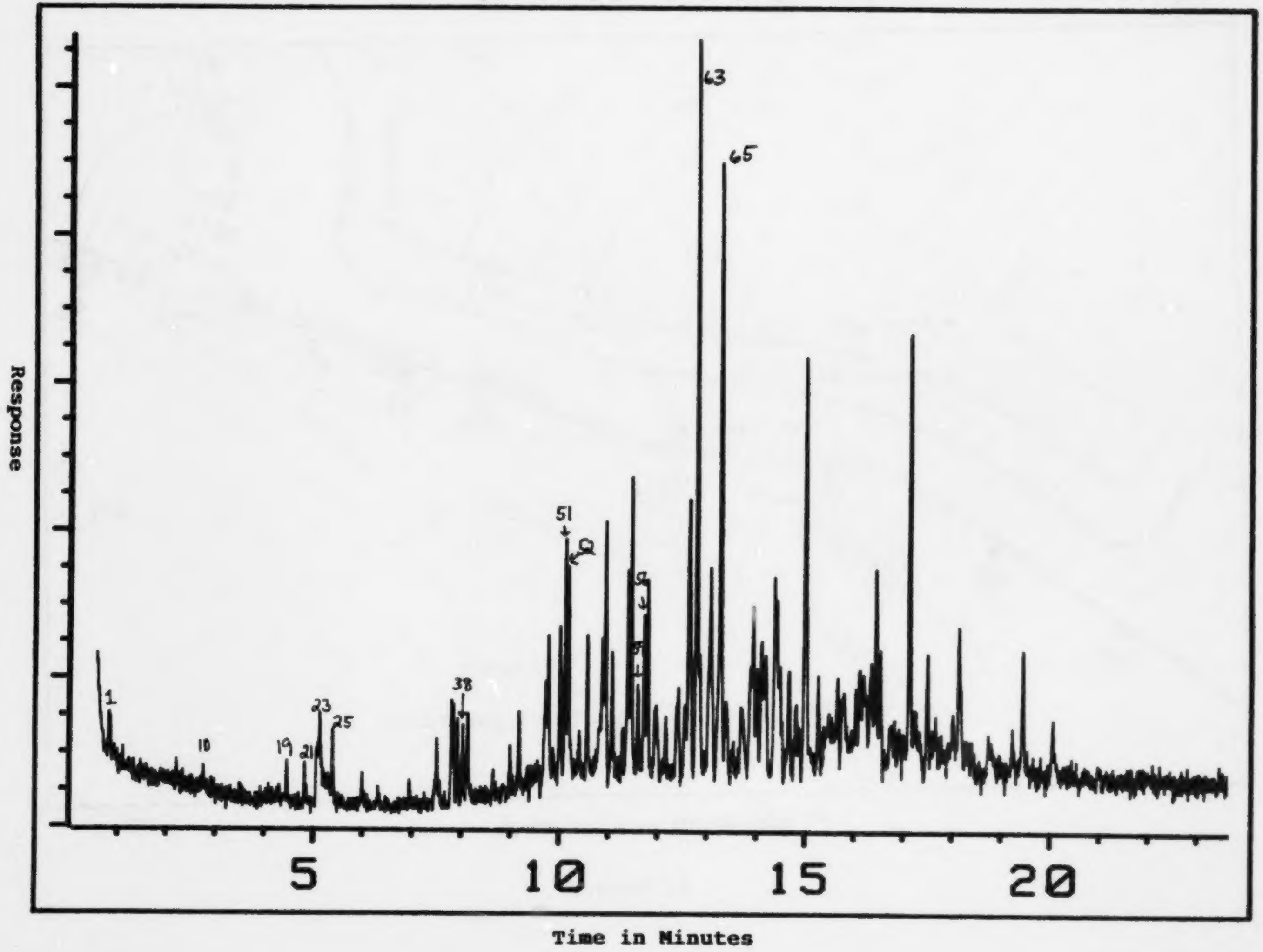
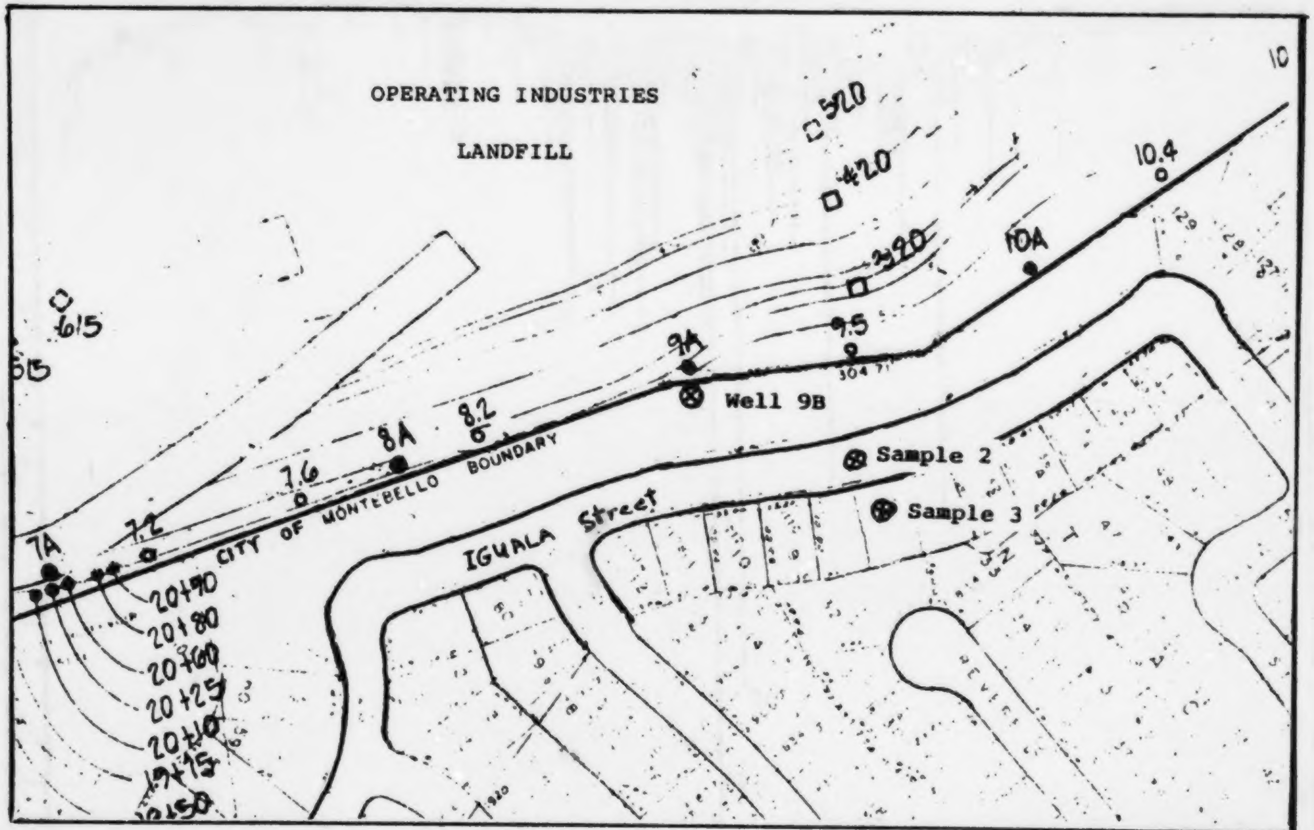


FIGURE 18

LANDFILL GAS MIGRATION


OPERATING INDUSTRIES
LANDFILL
520
420
320
615
515
10
10.4
10A
9.5
304.71
9A
Well 9B
8.2
8A
7.6
7.2
7A
CITY OF MONTEBELLO BOUNDARY
Sample 2
Sample 3
IGUALA Street
20+90
20+80
20+60
20+25
20+10
19+75
19+50

Sampling Locations Marked as ⊗

aromatics). Hydrocarbons and sulfur-organics are consumed by soil bacteria. This leaves cyclo-saturates, which are hard for bacteria to digest, and perchloroethylene, which is also non-polar and hard to digest.

Control of Organic Emissions by Flares

The most commonly used method for controlling gas emissions from landfills is to pull the gas from the landfill with a gas collection system and to burn the gas in a flare.

The flare itself in some ways resembles a giant Bunsen burner. Gas is blown up the center of a tube through a burner head and burned in air. The air is supplied through a natural draft. Since the landfill gas contains about 30% to 40% methane, about the same amount of CO_2, some nitrogen, and is saturated with water vapor, the flame is relatively low in temperature (around $1400^\circ F$). However, EPA Method 25 shows that the flares are about 95% efficient in burning total non-methane organics.

A qualitative test was run on the flare at Operating Industries to determine what compounds were present in the flare inlet and exhaust. The GC/MS total ion chromatogram results are shown in Figures 19 and 20.

It can be seen by comparing relative responses in the GC/MS total ion chromatograms that all of the compounds are burned fairly efficiently except for the aromatics. Benzene is burned least efficiently, followed by toluene and xylenes. It is probable that a re-design of the flare system could improve efficiency for aromatics.

FIGURE 19

GC/MS Total ion Chromatogram
of Raw Landfill Gas,

Plair Inlet

OII. D

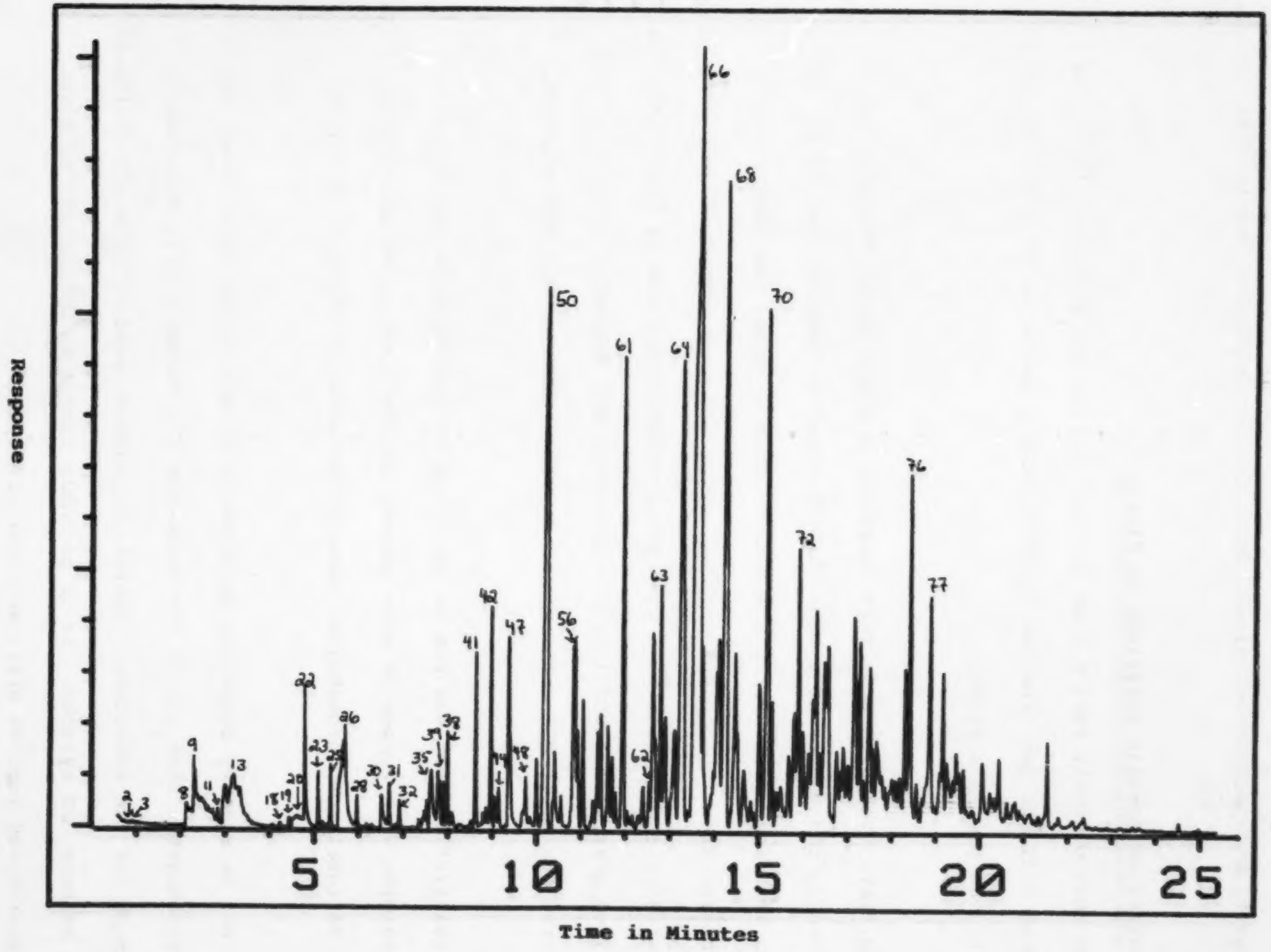
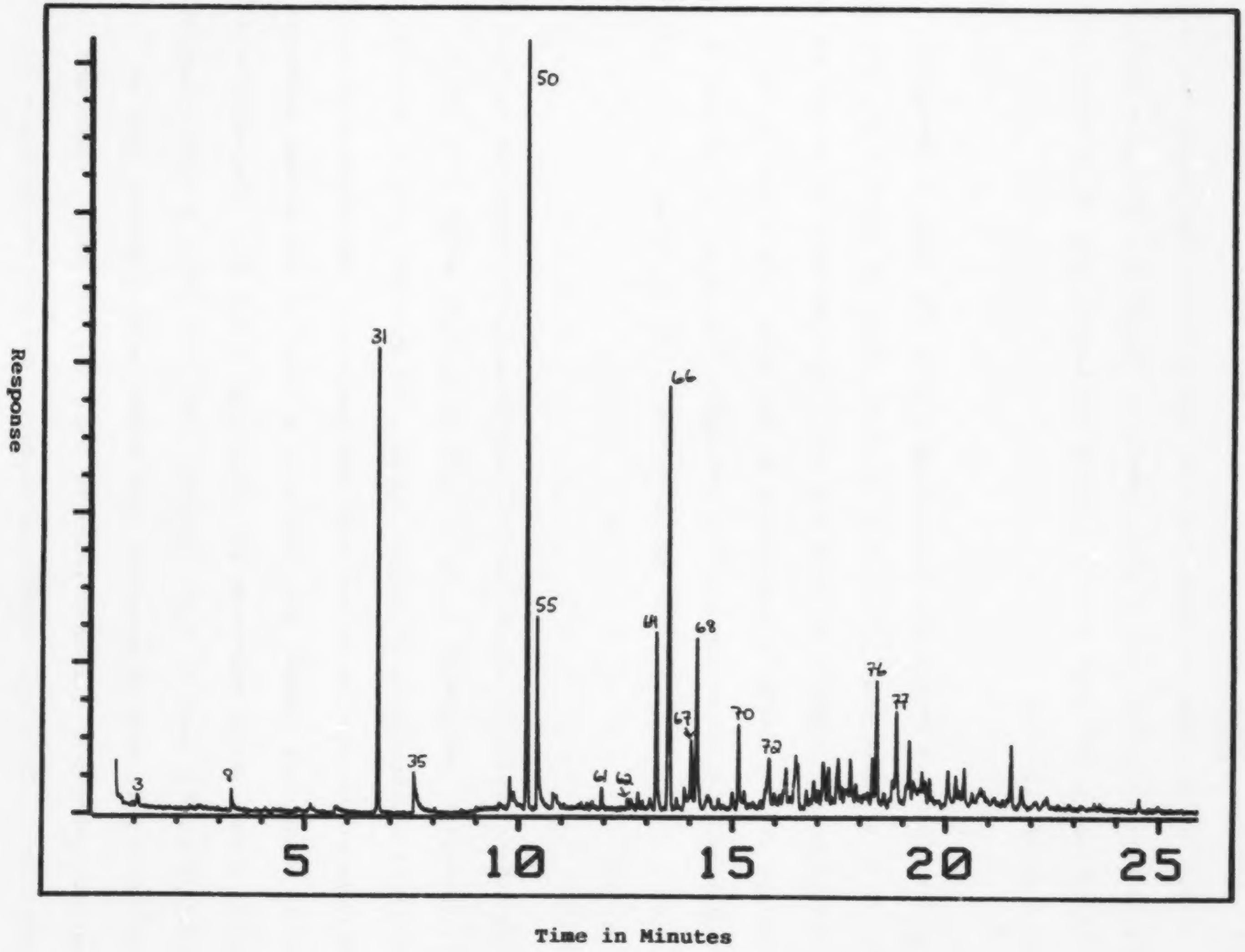


FIGURE 20

GC/MS Total ion Chromatogram of Landfill Gas, BULB #WH.D **Flair Outlet**



CONCLUSIONS AND RECOMMENDATIONS

This work has shown that a large number of toxic compounds are found in Class II landfills. These compounds are not supposed to be permitted in Class II landfills. If these compounds had been listed on the manifests, the loads would have been sent to a Class I landfill. Therefore, manifests can be considered to be almost totally useless for determining the chemical content of a landfill.

Landfill gas can impact the surrounding area by two modes of transport. The first is airborne transport. This involves escape of landfill gas through the surface of the landfill and into the air. The compounds in the gas are then carried off the landfill and diluted by the wind. The second is gas migration. Gas migration involves the subsurface escape of gas from a landfill. It may be through cracks in the ground or through porous soil layers.

Subsurface migration allows landfill gas to emerge wherever the surface layer is cracked or penetrated by pipes, such as in water-meter boxes and in kitchens and bathrooms of homes. There is no dilution prior to arrival, so concentrations tend to be very high and localized. Measurements at migration wells around BKK suggest that diffusion of landfill gas through sandstone or other porous layers separates the components of the gas. Compounds with low boiling points, such as vinyl chloride, arrive in homes at higher relative concentrations than do compounds with higher boiling points, such as perchloroethylene. Methane, which is light and very mobile precedes heavier components. Therefore, subsurface migration can produce explosive levels of methane in confined spaces without the presence of tell-tale odors.

Vinyl chloride can also precede odorous compounds during subsurface gas migration. This was evident in the BKK study where gas migration took place through sandstone, and in a study at Operating Industries where the gas migrated through soil. In the latter case, in-home concentrations of vinyl chloride have reached a 24-hour average of 30 to 50 ppb and there was no trace of landfill odor.

The use of methane as a surrogate for the measurement of vinyl chloride or other toxic contaminants has been shown to be unacceptable. The relative concentrations of the components can vary by an order of magnitude or more from one place to another. Therefore, estimates of toxic doses based on methane measurements could be expected to be in error by more than an order of magnitude.

Methane, however, can be used to indicate the onset or presence of landfill gas migration in a vast majority of cases. Since methane precedes or coelutes with the toxic constituents, screening with a methane monitor is practical at a landfill in which biodegradation is taking place. Once methane migration is detected, a toxics analysis would be required, and plans made to install a gas collection system.

An exception to this would be Class I landfills in which the concentration of toxics is high enough to kill bacteria or inhibit their growth. This would prevent methane formation, but the toxic vapors could still migrate off-site.

An example of this could be a sump containing acid waste from a refinery. Sulfur dioxide can be generated in sufficient quantity to act as a carrier gas. Methane would not be detected even though toxic gases are present.

While this study shows that few Class II landfills are currently impacting local residents, it is apparent that there is the potential for a problem with a large percentage of the landfills. With more extensive investigation it may be possible to classify landfills with regard to potential threat from surface transport and subsurface gas migration. A classification system would permit monitoring and control measures to be tailored to the needs of specific groups of landfills.

Fifteen of the twenty landfills studied in this report are classified as "inactive", meaning they were not accepting trash at the time of this study. Records show that these landfills reached the "inactive" status from as long ago as 1953 to as recent as 1983. Vinyl chloride was found in eight of the fifteen "inactive" landfills including the landfill that had not accepted trash since 1953. This indicates that vinyl chloride can be produced in a landfill long after it has ceased to accept trash.

The data in Tables II and V clearly demonstrate that there is a wide variation in the composition of landfill gas from site to site within each landfill. This variability must be taken into account whenever surveying a landfill for its content. Also, it should be considered that a majority of Class II landfills contain enough toxic compounds to be a potential problem. All of this leads to the conclusion that the only way to know if there is a potential problem with a specific landfill is to analyze the landfill gas. The results of the analysis will provide the information needed to allow the responsible agency to proceed in a reasonable manner.

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2. Alexander, M., "Biodegradation of Chemicals of Environmental Concern," Science, Vol. 221, January 9, 1981.

3. Parsons, F., Wood, P.R., De Marco, J., "Transformations of Tetrachloroethene and Trichloroethene in Microcosms and Groundwater," Journal AWWA, February 1984, pp. 56-59.

APPENDIX A

Ambient Sample Collection

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 FLAIR DRIVE
EL MONTE, CA 91731

DUAL INTEGRATED SAMPLE COLLECTOR FOR AMBIENT AIR WITH AUTOMATIC CHANGEOVER FEATURE

FEBRUARY 1984
REVISED JUNE 1986

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FIGURE 2: ELECTRONIC DIAGRAM

FIGURE 3: SYSTEM DIAGRAM

BAG SAMPLER CHECK SHEET

1.0 INTRODUCTION

The sampler was originally designed for the collection of consecutive 24-hour integrated samples in bags without requiring a person to be on site at the exact time of sample changes. The replacement of the mechanical clock with a microprocessor based timer allowed greater flexibility in sample collection. Samples can now be collected simultaneously (i.e. collocated sampling); consecutively on the same day, for variable time periods; over the same or different time periods on consecutive days; or any number of combinations of two samples over a seven day period. The samples collected are subsequently analyzed for the contaminants of interest. The bag material is Tedlar (DuPont trade name for polyvinyl fluoride) to minimize contamination and reactivity. The sampler is a self-contained, portable unit with its own power source, that requires little maintenance and simple calibration, and yet is very reliable.

This method is applicable to the collection of air samples containing ambient levels of the following compounds and classes, of compounds.

C2-C8 Hydrocarbons

Fixed Gases (e.g. O_2, CO, CO_2)

Freons

Benzene

Toluene

Xylenes

Carbon Tetrachloride

Trichloroethylene

Perchlorethylene

Trichloroethane

This method may be used for the collection of other C1 and C2 chlorinated hydrocarbons and organic compounds up to a molecular weight of 180. However, each must be tested individually for reactivity and stability.

2.0 SPECIFICATIONS

2.1 Power--two 12 volt marine batteries (lead acid) provide 12 volts in parallel to the pumps and the clock timer switch. Power consumption is nominally 0.075 amps allowing the pumps to run approximately 30 days between battery recharges.

2.2 Pumps--two Brailsford Brushless DC, 12 to 18 volts, with a maximum unloaded flowrate of 4.5 liters per minute. The diaphragm is made of non-lubricated Viton (DuPont trade name for co-polymer of hexafluoropropylene and vinylidene fluoride) rubber.

2.3 Clock timer switch--ChronTrol 12 volt, microprocessor-based timer capable of preforming a wide range of programed switching operations.

2.4 Bags--two 10 liter Tedlar bags with valves (SKC-West). The bags are contained in light-sealed cardboard boxes of nominal dimensions 24 X 12 X 7 inches, to prevent photochemical reactions from occurring during sampling and transportation. The valve is a push-pull type constructed of aluminum and stainless steel, with a Viton O-ring seal

2.5 Rotameters--two Brooks Model R-2-15-AAA with black glass float. The rotameters are made of borosilicate glass and have a flow range of 3 to 50 cc/min. The scale is in millimeters with major graduations (labeled) every 5 mm and minor graduations every 1 mm.

2.6 Air Flow Control Orifice--316 stainless steel capillary tubing.

2.7 Bypass Valve--Whitey Model 1RS4.

2.8 Fittings, Tubing, and Connectors--316 stainless steel or Teflon.

* SEE FIGURE 1 & 2 *

3.0 THEORY OF OPERATION

The sampling unit consists of two independent bag samplers, each with its own collection bag, pump, and associated plumbing, controlled by a 24 hour clock timer switch. At the end of the sampling period, the timer shuts off the sampler that is on and activates the second sampler. In this way, consecutive samples may be conveniently collected regardless of the required beginning time of sampling or length of sampling period. Full sample bags must be replaced with empty bags to carry out continuous sampling.

Each bag sampler uses a DC operated pump having a total unloaded flow capacity of 4.5 liters/min., stainless steel capillary tubing to control the sample rate to the bag, a bypass valve to control the sample flowrate (and minimize back pressure on the pump), a rotameter for flow indication to aid in setting the flow, and a 10 liter Tedlar sample bag. The associated tubing and connections are made of stainless steel, Teflon, or borosilicate glass to minimize contamination and reactivity.

The pump uses a non-lubricated Viton diaphragm assembly that is relatively inert to the species listed in section 1. In addition, the use of the bypass valve ensures that the pump is operating at near maximum flow, both minimizing residence time in the pump and flushing it with fresh sample continuously. Only stainless steel, glass, and Tedlar come into significant contact with the collected sample.

The sampling unit is totally enclosed and the Tedlar bags are contained in light-tight boxes as well to prevent photochemical reactions from occurring after sampling.-

* SEE FIGURE 3 *

4.0 FLOWRATE CALIBRATION

Rotameters are calibrated by bubblemeter and stopwatch after they have been incorporated into the sampling equipment. Since an integrated sample is being collected a tolerance of + or - 10% is acceptable for calibration. As long as the flow can be set such that the total sample will not exceed the volume of the bag, yet be sufficient for analysis, the calibration is adequate. The factor of primary importance is maintaining reasonably constant flow throughout the sampling to ensure an unbiased sample.

4.1 Test equipment

A. Bubblemeter calibrated for flowrates from 1 to 100 cc/min.

B. Stopwatch, accuracy should be better than 1% with 0.1 second resolution.

4.2 Calibration Procedure

A. Completely assemble the sampling system, but do not include the Tedlar bags (or their containers).

B. Connect the bubblemeter to the outlet of one of the sampling units where the bag would normally be attached.

C. Manually set the timer to turn on the sampling unit undergoing calibration.

D. Using the bypass valve, set the rotameter to the 5 mm mark. Allow the flow to stabilize for a minute or two. Measure the flowrate, allowing at least 20 seconds for a measurement. When three consecutive measurements agree to within + or - 5%, the calibration is complete. Record the position of the middle of the rotameter ball and the actual flowrate. Repeat this procedure for every 5 mm up to 40 mm, and every 20 mm from 40 mm to 140 mm. Prepare a calibration curve for the rotameter.

E. From the above calibration, estimate the position of the rotameter ball that would give a flow of 6.0 cc/min, and adjust the bypass valve to position the float at the position (nearest mm mark). Calibrate the flowrate as in D. If the flowrate is 6.0 + or - 0.5 cc/min, then mark this float position. If not, adjust the float position again and re-calibrate until this condition is met.

F. Repeat A through E for the remaining sampling unit.

5.0 OPERATIONAL PROCEDURES

5.1 Identification and Assignment

Each Tedlar bag is assigned to only one sampler for the duration of a sampling program or the life of the bag. The bag is given an identification number from a sample bag log book, documenting the date that the bag was put into operation, the site location, the sampler designation (including whether the A or B sampler within a sampling unit), and the date that it was pulled from service.

Dedicating individual bags to a specific sampler reduces confusion and, more importantly, builds a historical data base by which the performance of the pumps and bags can be monitored. Significant changes in the data are used as flags to check the integrity of the sampling system and thereby prevent invalid data from being reported and minimize the loss of data.

5.2 Sample Changing Procedure

The project manager provides a check sheet to be taken to the sampling site and filled out as each operation is done.

* SEE CHECK SHEET *

A. Mark the time of arrival at the sampling site.

B. Check the sampler scheduled to be currently in operation for the following:

1. Whether or not the pump is running.
2. The rotameter reading. The float (measured at the middle) should be within +3 and -6 minor graduations of the marked setting for 6.0 cc/min. Less allowance is made for the high side since the bag may overfill. If the rotameter setting exceeds the above limits, adjust the bypass valve to correct the flowrate. Make sure that the flow has stabilized (at least three minutes at constant flow) since there may be a lag time between the adjustment and the final flow. Mark down both the pre-adjustment and post-adjustment readings in the comments column. If the flow operation is abormal, e.g., float sticks or excessive oscillation, merely note this in the comments column.

3. Whether the bag valve is in the open position (pushed in). If the valve is in the closed position (pulled out), open the valve and mark down the time in the comments column.

C. Remove the full bag from the sampler not scheduled to be currently in operation. Close the bag valve (pull out). Mark the sample ID number on the check sheet.

D. Check the sampler not scheduled to be currently in operation for the flowrate by manually starting the timer and observing the rotameter. Allow at least thirty seconds for the flowrate to equilibrate. If the flowarate exceeds the limits of +3 and -6 minor graduations, adjust the by-pass valve as in B.2. Mark down the pre-adjustment and post-adjustment readings in the comments column.

E. Install the new sample bag. Make sure that the valve is in the open position (pushed in). Mark down the sample ID number on the check sheet. Lock the sampler doors.

5.3 Bag Purging Procedure

After the contents of a sample bag have been analyzed, the bags are evacuated and filled with prepurified nitrogen three times to flush out the old sample. Care must be taken during the filling process not to overfill the bag and either burst the bag, or stress the seams of the bag. Following the final nitrogen purge, the bag is evacuated and the valve closed. Prior to sending the bag into the field again, it is checked out to make sure that the vacuum has been maintained. If leakage has occurred, the bag is removed from service.

5.4 Chain of Custody

The project manager provides a custody sheet to go out with each group of bags that are to be installed and returns with the group of filled sample bags that they replaced. Each time that either the replacement bags or the filled bags change hands, they are signed for on the custody sheet. The time of transfer of custody is recorded, and Laboratory personnel also record the condition of the sample (full, overfull, one-half full, one-fourth full, or empty). The chain of custody sheets and the check sheets are returned to the project manager each day.

6.0 QUALITY CONTROL CHECKS

6.1 Test Equipment

A. voltmeter

B. Bubblemeter calibrated for flowrates from 1 to 100 cc/min.

C. Stopwatch, accuracy should be better than 1% with 0.1 second resolution.

6.2 Pre-installation Checks

Prior to putting the new bag, new pumps, or new units into service, certain checks are performed and precautions taken to ensure the integrity of the sample. Each new bag is carefully inspected for holes or tears. The inlet valve to the bag is checked to ensure freedom of movement and proper sealing. Then the bag is put into its cardboard container and sealed against light to prevent photochemical reactions from occurring in the sample. The final test before installing a sampling system in the field is to allow the sampler to sample zero grade air (less than 0.1 ppm total hydrocarbons as methane) in the Laboratory as it normally would in the field, and then analyze the sample for contaminants. If no significant contamination is present in the sampling unit, new bag, or new pump may then be used in a sampling program.

6.3 Flowrate checks

Every 7-10 days of operation, the actual flowrate at the mark for 6.0 cc/min (or at the flowrate appropriate for the specific sampling program) is checked using a bubblemeter and stopwatch. Personnel other than those responsible for changing samples perform these periodic flowrate checks. If the measured flow differs from the calibrated flow by more than + 1.0 cc/min or + 10%, whichever is greater, the rotameter is either cleaned or replaced and a new calibration curve is produced. Since the re-calibration would take place in the field, and the flow range for the project would be known, the new calibration need not be as extensive as an original calibration. As a guideline, calibration at four major graduations that bracket the sampling flowrate and at the sampling flowrate (to be marked) are sufficient.

6.4 Voltage Checks

Every 7-10 days of operation the battery voltage is checked with a voltmeter by personnel other than those responsible for changing the samples. If the voltage falls below 12 VDC the batteries are replaced.

6.5 Post Project Checks

Following the completion of a sampling project, the bags and pumps still in operation at the site are returned to the Laboratory and the contamination checks performed prior to installation (Section 7.1) are repeated. The used bags are generally discarded rather than used for another project.

7.0 PART AND VENDOR LIST

7.1. 1ea. Instrument Enclocure--30"H x 36"W x 14"D: INFRATECH CORP.; 1770 WORKMAN St.; LOS ANGELES, CA 90031; (213) 223-1041.

7.2. 1ea. Clock Controller, Chrontrol Model CD-2SDC: POWER SALES CO.; 106 ABALONE St.; NEWPORT BEACH, CA 92662; (714) 673-4445.

7.3. 2ea. 12vdc Brailsford Model TD-2S Pump (specify non-lubricated Viton): BRAILSFORD & COMPANY, INC.; 670 MILTON ROAD; RYE, NY 10580; (914) 967-1820.

7.4. 2ea. Rotameter--Catalog No. 52-31P-1-1: SCOTT SPECIALTY GASSES; 2600 CAJON BLVD.; SAN BERNARDINO, CA 92411; (714) 887-2571

7.5. 10ft. 1/4" O.D. x 1/8" I.D. Teflon Tubing: CHEMPLAST-WEST, INC.; P.O. BOX 4516; VAN NUYS, CA 91412; (818) 786-8866.

7.6. 2ea. Whitey Valve--#B-1RS4-A: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.7. 3ea. Union Tee--#SS-400-3: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.8. 2ea. Reducer--#SS-100-R-4: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.9. 2ea. Reducer--#SS-600-6-1: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.10. 2ea. Reducer--#SS-600-6-4: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.11. 1ea. Bulkhead Union--#SS-400-61: ARCADIA VALVE & FITTING CO.; 521 N. FIRST St.; ARCADIA, CA 91006; (818) 446-8875.

7.12. 6ft. 1/4" I.D. Stainless Steel Tubing: McMASTER-CARR; P.O. BOX 54960; LOS ANGELES, CA 90054; (213) 945-1311.

7.13. Tedlar Bags-10 Litre: SKC-WEST INC.; P.O. BOX 2805; 2021-G.W. COMMONWEALTH AVE.; FULLERTON, CA 92533; (714) 662-2780.

7.14. Cardboard Boxes--24" x 12" x 6": ACORN PAPER PRODUCTS; 3686 E. OLYMPIC BLVD.; LOS ANGELES, CA 90023; (213) 268-0507.

7.15. 6ft. Aluminum Channel--1/2" x 1/2" x 3/32".

7.16. 2ft. 1/16" Stainless Steel Tubing.

7.17. 9ea. 1/4" Component Clamps.

7.18. 4ea. 3/8" Component Clamps.

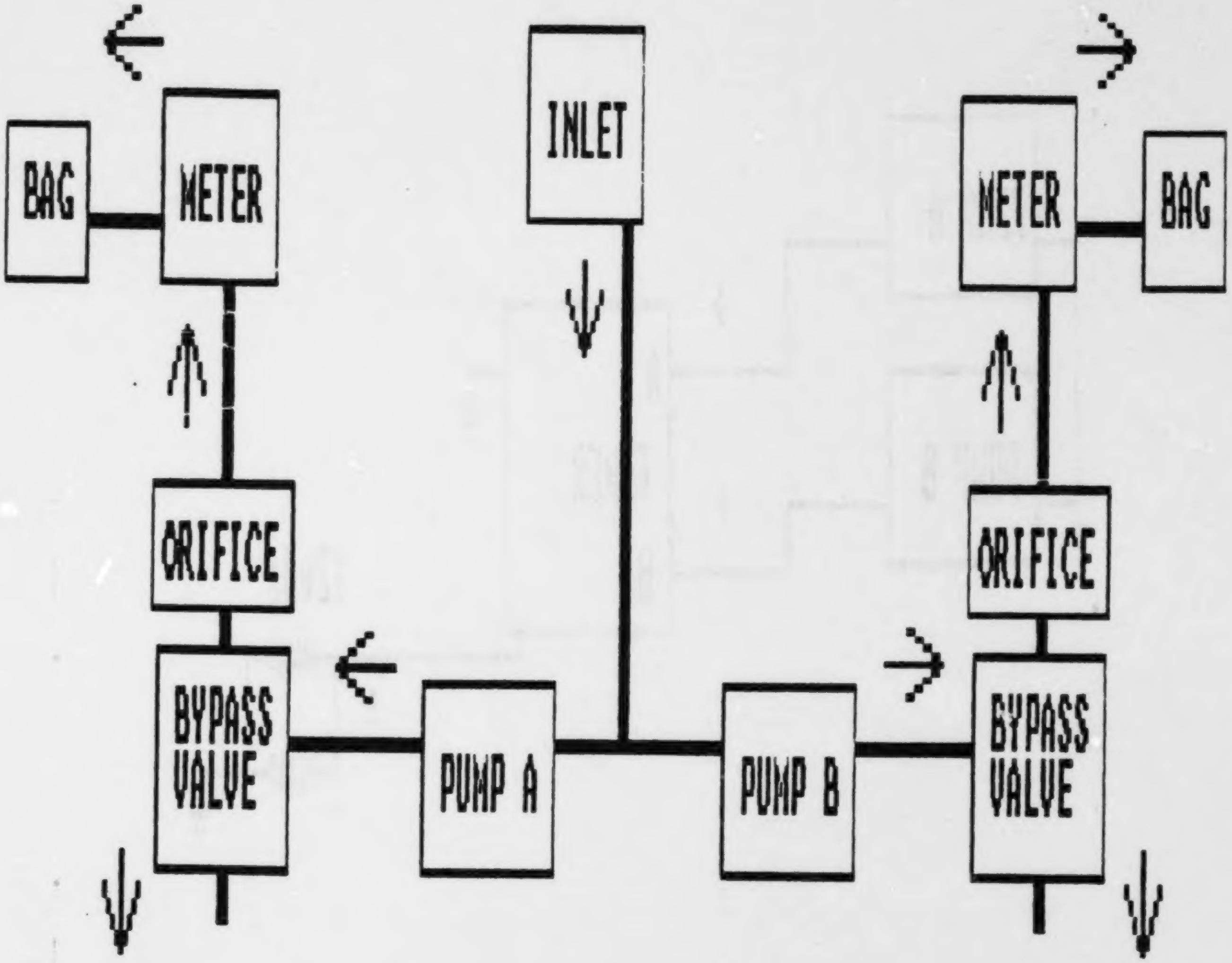

INLET
BAG
METER
METER
BAG
ORIFICE
ORIFICE
BYPASS VALVE
PUMP A
PUMP B
BYPASS VALVE

FIGURE 1: SAMPLE AIR FLOW DIAGRAM

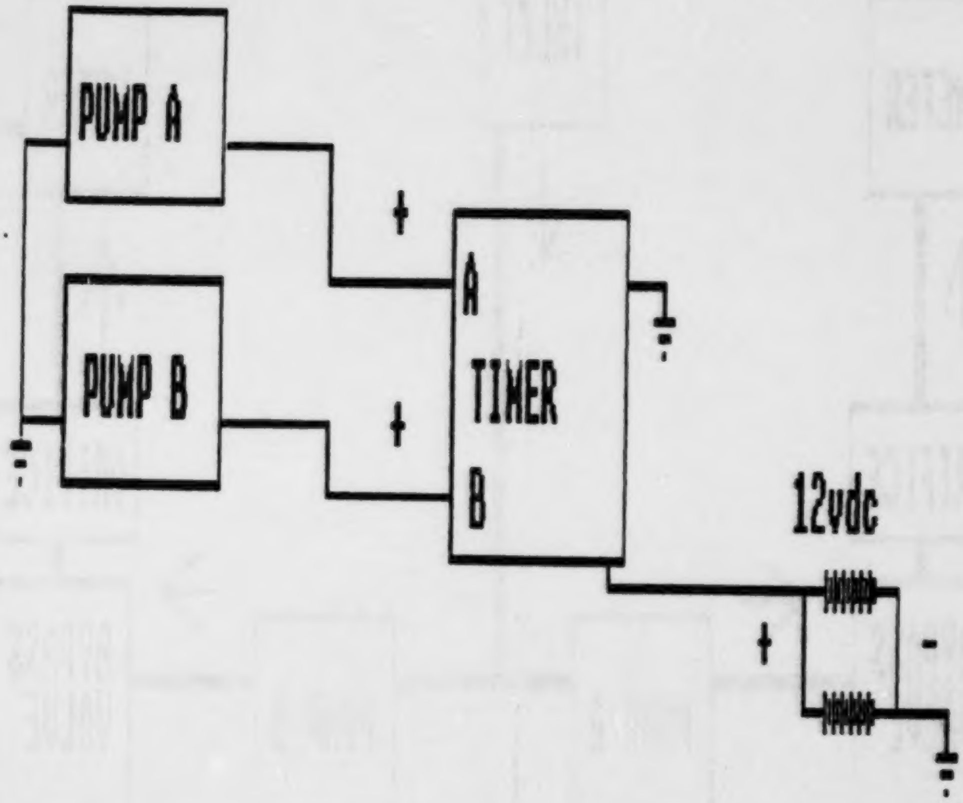

PUMP A
PUMP B
+
+
A
TIMER
B
12vdc
+
-

FIGURE 2: ELECTRONIC DIAGRAM

1. CLOCK 2. PUMP
3. BAG 4. ROTAMETER
5. BYPASS VALVE 6. AIR INLET

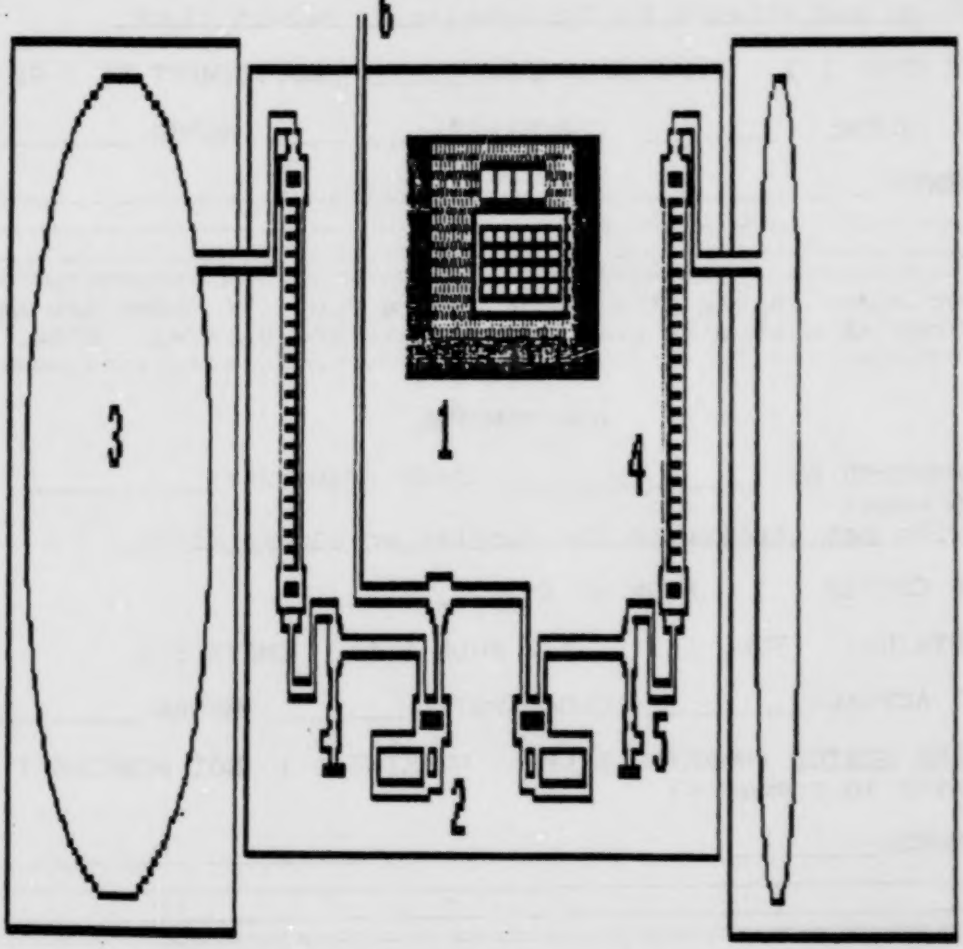


FIGURE 3: SYSTEM DIAGRAM

BAG SAMPLER CHECK SHEET

F060617

PROJECT/SITE:________________________________ SIDE:________

BAG #:______ RUN DATE:_____________ PREPARED BY:____________

==

BAG INSTALLATION

BAG INSTALLED BY:________________ DATE (YYMMDD):____________
(last name)
NOTE: Do not attempt to fix sampler or adjust clock.

VALVE OPEN [ ]   FLOW AT START:_______   ADJUSTMENT Y[ ] N[ ]

TIME: ACTUAL:__________ CLOCK(PST):_________ METER:_________

COMMENTS:____

____

____

==

***Leave sheet in bag at sampler during run. If there are any problems at site make note in comments and call ext. 6158.**

==

BAG REMOVAL

BAG REMOVED BY:________________ DATE (YYMMDD):____________
(last name)
NOTE: Do not attempt to fix sampler or adjust clock.

VALVE CLOSED [ ]   FLOW AT END:__________

BAG STATUS: FULL [ ]   1/2 FULL [ ]   EMPTY [ ]

TIME: ACTUAL:__________ CLOCK(PST):_________ METER:_________

SAMPLER STATUS (WORKING SIDE):   WORKING [ ]   NOT WORKING [ ]
(specify in comments)

COMMENTS:____

____

____

==

***Return sheet to Special Monitoring and Toxics Section. If there are any problems at site make note in comments and call ext. 6158.**

==

REVIEWED BY:__________________   FILED BY:__________________

APPENDIX B

Quality Assurance Data

APPENDIX B

Summary

Total of 111 paired readings:

$\overline{X}$ = 4.86% deviation from mean.

standard deviation = 5.73

Eliminate all above 15% deviation for mean, as outliers - leaves 102 paired readings.

$\overline{X}$ = 3.59% ± 3.62

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	808A	244	% Dev.
Methane	<10	<10	-
Carbon Dioxide	1340	1160	7.2
Vinyl Chloride	<0.002	<0.002	-
Benzene	<0.005	<0.005	-
Toluene	0.016	0.015	3.2
t-1,2-DCEE	<0.12	<0.12	-
$CHCl_3$	<0.001	<0.001	-
1,2-DCE	<0.030	<0.030	-
1,1,1-TCE	0.0035	0.0041	7.9
CCl_4	<0.0003	<0.0003	-
TCEE	<0.001	<0.001	-
Perchloroethylene	0.0062	0.0068	4.6

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	S2	5	% Dev.	ABC	9601	% Dev.	MNO	999	% D
Methane	2220	2270	1.1	<10	<10	-	<10	<10	-
Carbon Dioxide	16100	15700	1.3	2360	2380	0.4	2770	2640	2
Vinyl Chloride	0.010	0.012	9.1	<0.002	<0.002	-	<0.002	<0.002	-
Benzene	<0.005	<0.005	-	<0.005	<0.005	-	<0.005	<0.005	-
Toluene	0.029	0.031	3.3	0.018	0.017	2.9	0.016	0.016	0
t-1,2-DCEE	<0.12	<0.12	-	<0.12	<0.12	-	<0.12	<0.12	-
$CHCl_3$	0.0056	0.0058	1.8	0.0043	0.0044	1.1	<0.001	<0.001	-
1,2-DCE	<0.030	<0.030	-	<0.030	<0.030	-	<0.030	<0.030	-
1,1,1-TCE	0.0033	0.0029	6.5	0.0037	0.0039	2.6	0.0038	0.0040	2
CCl_4	<0.0003	<0.0003	-	<0.0003	<0.0003	-	<0.0003	<0.0003	-
TCEE	0.0033	0.0037	5.7	<0.001	<0.001	-	<0.001	<0.001	-
Perchloroethylene	0.014	0.015	3.4	0.0068	0.0069	0.7	0.0073	0.0072	0

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	808A	224	% Dev.	999	936	% Dev.	SJ	SW	% Dev.
Methane	283000	292000	1.6	365000	348000	2.4	15000	14900	0.3
Carbon Dioxide	241000	246000	1.0	267000	247000	3.9	44300	44100	0.2
Vinyl Chloride	1.0	0.73	15.6	1.7	1.5	6.3	0.27	0.27	0.0
Benzene	NA	NA	-	NA	NA	-	0.044	0.042	2.3
Toluene	NA	NA	-	NA	NA	-	0.17	0.18	2.9
t-1,2-DCEE	<0.06	<0.06	-	<0.06	<0.06	-	<0.12	<0.12	-
$CHCl_3$	<0.001	<0.001	-	<0.001	<0.001	-	0.0025	0.0026	2.0
1,2-DCE	<0.035	<0.035	-	<0.035	<0.035	-	<0.030	<0.030	-
1,1,1-TCE	0.014	0.014	0.0	0.013	0.012	4.0	0.0043	0.0029	19.4
CCl_4	0.00029	0.00029	0.0	0.00037	0.00036	1.4	<0.0003	<0.0003	-
TCEE	<0.001	<0.001	-	<0.001	<0.001	-	0.015	0.015	0.0
Perchloroethylene	0.0035	0.0031	6.1	0.0031	0.0030	1.6	0.023	0.025	4.2

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	TB	562	% Dev.	SP	1	% Dev.	14C	963	% Dev.
Methane	278000	262000	3.0	5190	5020	1.7	454000	465000	1.1
Carbon Dioxide	236000	220000	3.5	4330	4210	1.4	289000	300000	1.9
Vinyl Chloride	<0.050	<0.050	-	<0.020	<0.020	-	3.2	3.6	5.9
Benzene	0.50	0.39	12.4	0.065	0.067	1.5	NA	NA	-
Toluene	2.6	2.0	13.0	0.140	0.130	3.7	NA	NA	-
t-1,2-DCEE	<0.25	<0.25	-	<0.035	<0.035	-	<0.06	<0.06	-
CHCl$_3$	<0.0030	<0.0030	-	0.0046	0.0044	2.2	<0.001	<0.001	-
1,2-DCE	<0.095	<0.095	-	<0.030	<0.030	-	<0.035	<0.035	-
1,1,1-TCE	0.0041	0.0041	0.0	0.0023	0.0024	2.1	0.010	0.0097	1.5
CCl$_4$	<0.00050	<0.00050	-	<0.00009	<0.00009	-	0.00029	0.00029	0.0
TCEE	0.077	0.065	8.5	<0.0006	<0.0006	-	0.0016	0.0024	20.0
Perchloroethylene	0.042	0.035	9.1	0.0019	0.0019	0.0	0.0031	0.0030	1.6

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	FL	SQ	% Dev.	CD	968	% Dev.	204	S22	% Dev.
Methane	245000	232000	2.7	463000	453000	1.1	395000	393000	0.3
Carbon Dioxide	229000	210000	4.3	390000	390000	0.0	322000	335000	2.0
Vinyl Chloride	7.2	7.0	1.4	22	22	0.0	<0.050	<0.050	-
Benzene	0.40	0.40	0.0	1.10	0.93	8.4	0.12	0.12	0.0
Toluene	3.3	2.9	6.5	14	9.6	18.6	0.70	0.68	1.4
t-1,2-DCEE	NA	NA	-	NA	NA	-	<0.35	<0.35	-
$CHCl_3$	NA	NA	-	NA	NA	-	<0.0035	<0.0035	-
1,2-DCE	0.12	0.11	4.3	<0.37	<0.37	-	<0.12	<0.12	-
1,1,1-TCE	<0.001	0.002	-	0.026	0.026	0.0	0.0027	0.0030	5.3
CCl_4	NA	NA	-	NA	NA	-	<0.00070	<0.00070	-
TCEE	0.18	0.14	12.5	1.4	1.1	12.0	0.060	0.053	6.2
Perchloroethylene	0.13	0.12	4.0	1.3	0.94	16.1	0.037	0.031	8.8

QUALITY ASSURANCE: Paired Samples

(Concentration in ppm)

Site	KP	PD	% Dev.	943	258	% Dev.	GT	NU	% Dev.
Methane	310000	324000	2.2	<10	<10	-	266000	257000	1.7
Carbon Dioxide	295000	299000	0.7	503	508	0.5	240000	243000	0.6
Vinyl Chloride	29	30	1.7	<0.020	<0.020	-	2.6	2.8	3.7
Benzene	32	32	0	<0.007	<0.007	-	0.098	0.12	10.1
Toluene	150	150	0	0.020	0.020	0.0	0.39	0.54	16.1
t-1,2-DCEE	45	59	13.5	<0.045	<0.045	-	NA	NA	-
$CHCl_3$	0.54	0.61	6.1	<0.0009	<0.0009	-	NA	NA	-
1,2-DCE	18	19	2.7	<0.035	<0.035	-	<0.043	<0.048	-
1,1,1-TCE	3.2	3.6	5.9	0.0075	0.0056	14.5	0.004	0.002	33.3
CCl_4	<0.04	<0.04	-	0.00020	0.00014	17.6	NA	NA	-
TCEE	12	13	4.0	0.0011	0.00097	6.3	0.038	0.045	8.4
Perchloroethylene	16	19	8.6	0.0041	0.0029	17.1	0.037	0.046	10.8

APPENDIX C

Landfill Site Descriptions

LANDFILL SITES

NAME	CITY	PAGE	TEST NO.
Calabasas	Agoura	C-1, C-7	84-398 84-445
Scholl Canyon	Glendale	C-8, C-13	84-485 84-539
Coyote Canyon #24	Irvine	C-14	84-444
Spadra Landfill	Pomona	C-16, C-20	84-388 85-289
City of Redlands	N. Redlands	C-21	85-183
Tonyon Canyon	Griffith Park, L.A.	C-23	85-507
West Riverside	Riverside	C-26	84-402
Mountaingate	Los Angeles	C-28	C-84-200
.(Getty Syn. Fuels)	Los Angeles		
.(Mission Canyon)	Los Angeles		
.(David G. Price)	Los Angeles		
.(David G. Price)	Los Angeles		
City of Upland #412	Upland	C-30, C-33	84-439 85-128
Valley Reclamation	Sun Valley	C-34	85-65
Sheldon Arleta Pit	Sun Valley	C-36	84-372
Kalico Dump #1	Santa Fe Springs	C-39	84-478
.Kalico Dump #2	Santa Fe Springs	C-47	84-503
.Kobra Dump	Santa Fe Springs	C-50	84-484
Gilmore Sump	Val Verde	C-41	84-495
Syufy	Carson	C-44	C-84-84 84-526

LANDFILL SITES (Cont.)

NAME	CITY	PAGE	TEST NO.
Russel Moe	San Fernando	C-52	84-464
Davis	Anaheim	C-54, C-58	84-277 85-1
Adams Industries	Carson	C-59, C-61	85-220 84-435
Velle Circuit .(Metropolitan Circuits)	Costa Mesa	C-62	84-493

Test No. 84-398 Date 8/3/84

OBJECTIVE

This test was conducted for the purpose of determining the concentration of vinyl chloride, benzene, toluene and selected hydrocarbons emitted from the surface of the landfill.

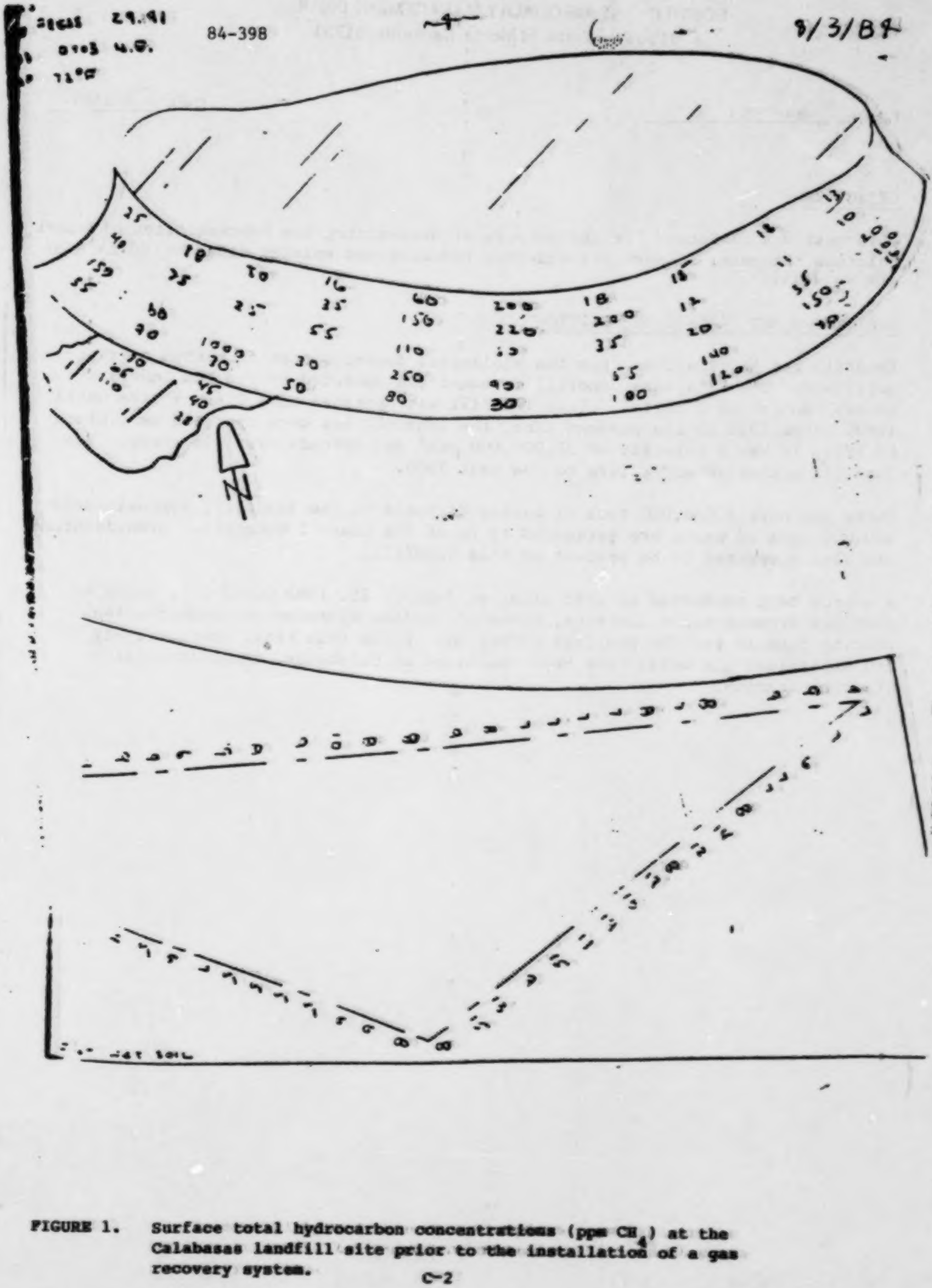
BACKGROUND AND PROCESS DESCRIPTION

Landfill gas is generated from the biological decomposition of buried organic materials. The Calabasas landfill is owned and operated by the Los Angeles County Sanitation District. This landfill was operated as a Class I site until 1980. From 1980 to the present time, the landfill has been operated as a Class II site. It has a capacity of 32,000,000 yds^3 and extends over 416 acres. The landfill has an expected life to the year 2046.

There are over 8,000,000 tons of wastes disposed in the landfill; approximately 300,000 tons of waste are estimated to be of the Class I Category. Cyanide drums are also suspected to be present at this landfill.

A source test conducted at this site, on January 25, 1983 (C-82-4), using a portable organic vapor analyzer, revealed surface hydrocarbon concentrations ranging from 10 to 1000 ppm (see FIGURE 1). Since this time, approximately 160 manifolded gas wells have been installed at Calabasas, in addition to a flaring station.

84-398


29.91
0903 4.0.
72°F
8/3/84
25
40
18
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75
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16
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80
25
35
60
150
200
220
18
200
35
15
12
20
17
10
200
150
90
1000
70
30
110
250
90
30
55
100
140
120
20
50
45
40
80
28
30
wet soil

FIGURE 1. Surface total hydrocarbon concentrations (ppm CH_4) at the Calabasas landfill site prior to the installation of a gas recovery system.

Test No. 84-398 Date 8/3/84

Calabasas

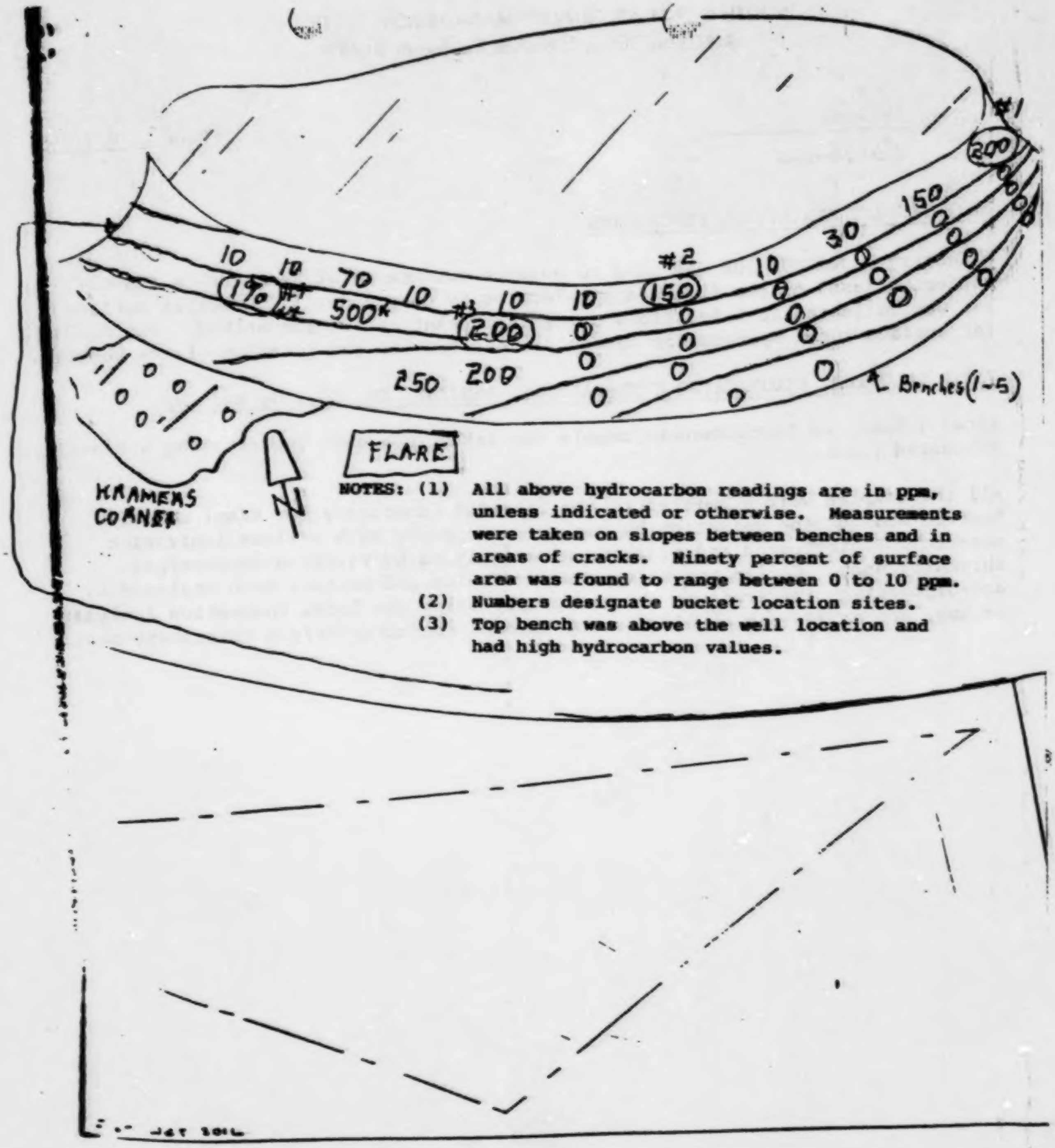
SAMPLING AND ANAYLTICAL PROCEDURES

A Century model OVA 108 was used to measure surface total hydrocarbon (as CH_4) concentrations, on the five benches located by Canyon No. 1. Landfill surface gas was collected at 4 locations using the bucket collection method. See FIGURE 2 for surface total hydrocarbon concentrations and for the location of the buckets.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, CO, CO_2, O_2 and CH_4

After 1 hour, an instantaneous sample was taken from each bucket using a two-liter evacuated flask.

All the samples were submitted to the District Laboratory for vinyl chloride, benzene and toluene detection by gas chromatography with a flame ionization detector. Chlorinated hydrocarbons were analyzed by electron capture/gas chromatography. Carbon monoxide, carbon dioxide and methane were analyzed by non-disperaive infrared/gas chromatography using the Total Combustion Analysis method, and oxygen was obtained using thermal conductivity/gas chromatography.


#1
200
0
0
0
0
150
30
10
#2
150
10
10
#3
200
10
10
70
500*
10
1%
#4
**
10
250
200
0
Benches (1-5)
FLARE
KRAMERS CORNER

NOTES: (1) All above hydrocarbon readings are in ppm, unless indicated or otherwise. Measurements were taken on slopes between benches and in areas of cracks. Ninety percent of surface area was found to range between 0 to 10 ppm.

(2) Numbers designate bucket location sites.

(3) Top bench was above the well location and had high hydrocarbon values.

*Deep crack. Could not put bucket over because of ineffective seal.

**Same comment as above, however bucket located here.

FIGURE 2. Surface total hydrocarbon concentrations (ppm CH_4) at the Calabasas landfill site after the installation of a gas recovery system.

INTRODUCTION

On September 4, 1984, source testing personnel from the South Coast Air Quality Management District (SCAQMD) collected gas samples from a landfill gas collection line feeding the flare units at L.A. County Calabasas Landfill, Agoura. Emissions from one of the two operating flares was also sampled. Testing is conducted as an on-going program to monitor changes in vinyl chloride (and other selected compounds) concentration.

Landfill gas is generated from the biological decomposition of buried organic materials. The Calabasas landfill is owned and operated by the Los Angeles County Sanitation District. This landfill was operated as a Class I site until 1980. From 1980 to the present time, the landfill has been operated as a Class II site. It has a capacity of 32,000,000 yds^3 and extends over 416 acres. The landfill has an expected life to the year 2046.

There are over 8,000,000 tons of wastes disposed in the landfill; approximately 300,000 tons of waste are estimated to be of the Class I Category. Cyanide drums are also suspected to be present at this landfill. There are approximately 160 manifolded gas wells installed at Calabasas, in addition to a flaring station.

QUIPMENT AND PROCESS DESCRIPTION

The Calabasas landfill has numerous wells which are manifolded into a network of collection lines (FIGURE 1). As the landfilling operation progresses, various wells are buried deeper in refuse and collection lines either buried, or are relocated. In the process, lines may become broken or crushed, or wells may be buried too deep to effectively vent the gases, requiring constant rebuilding and relocation of the lines. The collection lines, themselves, are manifolded together and distributed to a series of flaring units.

SAMPLING AND ANALYTICAL PROCEDURES

The flare inlet and exhaust were tested for vinyl chloride (and other selected compounds) concentrations. A TCA sampling train was used to collect total organic compounds exiting the flare.

The method of extracting the gas sample from each line was similar to that shown in FIGURE 2. A sample probe was inserted into each collection location and purged with gas sample using an aspirator bulb. The gas sample was then extracted with an evacuated 2-liter glass bulb.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, CO, CO_2; O_2 and CH_4

All samples were submitted to the District Laboratory for vinyl chloride, benzene and toluene detection by gas chromatography with a flame and photoionization etector. Chlorinated hydrocarbons were analyzed by electron capture/gas romatography. Carbon monoxide, carbon dioxide and methane were analyzed by non-dispersive infrared/gas chromatography using the Total Combustion Analysis Method, and oxygen was obtained using thermal conductivity/gas chromatography.

Calabasas

TOTAL ORGANIC COMPOUNDS

Sampling for total organic compounds (TOC) commenced for a continuous 20 minute period at the flare outlet using the method shown in FIGURE 3. Two simultaneous samples of effluent are collected in eight liter flasks. Heavier hydrocarbon compounds are deposited in dry ice-cooled traps prior to entering the flasks. Following standard Laboratory analysis, the amount of carbon compounds collected in the flasks and traps was compared to the volume of effluent sampled and reported with respect to concentration.

TEST CRITIQUE

No problems were encountered during testing, which was conducted during normal daylight hours on a prescheduled basis. Laboratory analyses show the following results (see Lab data for complete gas composition).

LE LOCATION	VINYL CHLORIDE (PPM)	BENZENE (PPM)	TOLUENE (PPM)	CO_2 (%)	CH_4 (PPM)	O_2 (%)	CO (PPM)
Flare Inlet (Bulb KP)	29	32	150	29.5	310,000	3.6	0
Flare Inlet (Bulb PD)	30	32	150	29.9	324,000	3.5	0
Flare Outlet (Bulb B04)	0.028	0.35	0.052	7.31	273	12.6	774
Flare Outlet (Bulb 805)	0.024	0.38	0.052	7.27	319	12.7	799
Flare Outlet (TCA Train)				6.40	299	14.7	528
				5.77	251	15.4	374

During our visit to the landfill, we were informed that the Farm Slope area is high in toxics, i.e. H_2S and HCN, and new wells are not immediately planned at this location. Typical well concentrations were reported to be approximately 10 to 20 ppm, and as high as 300 ppm.

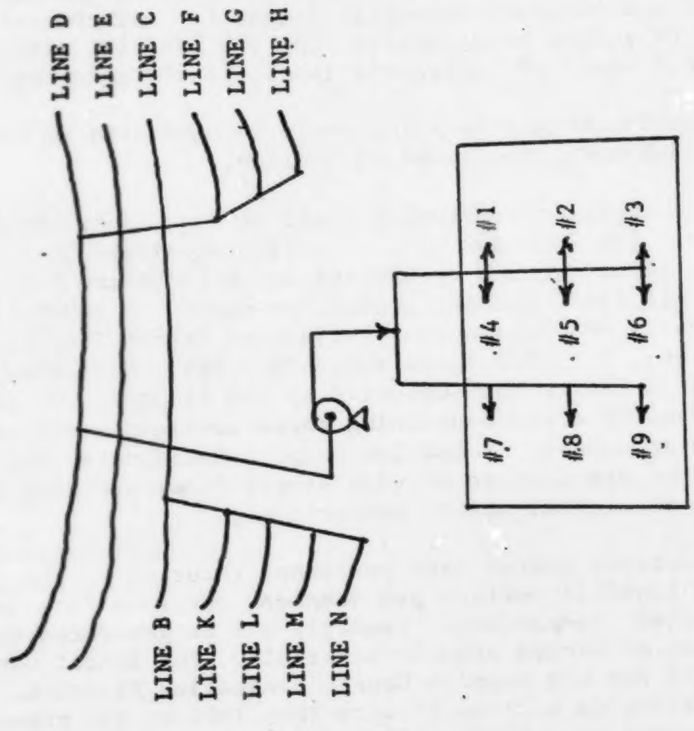

LINE D
LINE E
LINE C
LINE F
LINE G
LINE H
LINE B
LINE K
LINE L
LINE M
LINE N
#1
#2
#3
#4
#5
#6
#7
#8
#9
FLARE SITE

FIGURE 1. L.A. County, Calabasas Landfill gas recovery system and flare site.

SLOPE

INTRODUCTION

On September 27, 1984, source testing personnel from the South Coast Air Quality Management District (SCAQMD), met with representatives from the City of Glendale, the L.A. County Sanitation District, Calif. Institute of Technology and the Air Resources Board. The meeting was held at the Scholl Canyon landfill site in Glendale, to review and coordinate joint test efforts to be conducted at the landfill, under an ARB program, sponsored by the EPA.

The planned investigation would include:

1. A modeling/tracer study to characterize the impact of landfill surface emissions on downwind sites, i.e. Scholl Canyon Park, Glenoaks Park, Glenoaks School and Glendale Adventist Hospital. The controlled release and monitoring of sulfur hexafluoride from the landfill site would be performed by Fred Shair of California Institute of Technology.

2. Upwind and downwind ambient sampling would be conducted by the SCAQMD Meteorology Branch using bag sampling devices.

3. Landfill surface emission monitoring would be done using the ARB Flux sampling device. The Flux Box is a technique developed by David Todd, that has been previously used by the ARB to characterize hydrocarbon emissions from oil field primary production sumps. A schematic of the Flux Box appears in ARB Engineering Evaluation Branch Test Report C-83-056, C-83-065, C-83-076 dated March 20, 1984. Basically the unit consists of a Lucite box supported by two floats. Two sampling probes are plumbed to a van containing three continuous monitoring FID hydrocarbon analyzers. A Cadilac pump, a Roots meter and a 30 amp portable generator are used to provide sample flow, air flow rate measurement and electrical power, respectively.

On October 10, 1984, District source test personnel returned to the Scholl Canyon landfill and collected landfill surface gas samples, obtained from the ARB Flux sampling device, for later comparison. Landfill gas is generated from the biological decomposition of buried organic materials. The Scholl Canyon landfill is owned and operated by the Los Angeles County Sanitation District. This landfill has been operating as a Class II site from 1961 to the present time. It has an expected life to the year 2025. There is no gas collection or recovery system available at this time,however a series of gas wells and a flaring station have been proposed (FIGURE 1).

SAMPLING AND ANALYTICAL PROCEDURES

The method of extracting the gas sample from the ARB Flux sample line was similar to that shown in FIGURE 2. A sample probe was inserted into the collection location and purged with gas sample using an aspirator bulb. The gas sample was then extracted with an evacuated 2-liter glass bulb.

Scholl Canyon

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, CO, CO_2, O_2 and CH_4

All samples were submitted to the District Laboratory for vinyl chloride, benzene and toluene detection by gas chromatography with a flame and photoionization detector. Chlorinated hydrocarbons were analyzed by electron capture/gas chromatography. Carbon monoxide, carbon dioxide and methane were analyzed by non-dispersive infrared/gas chromatography using the Total Combustion Analysis Method, and oxygen was obtained using thermal conductivity/gas chromatography.

TEST CRITIQUE

Laboratory analyses of the landfill surface emissions obtained by sampling with the ARB Flux device show the following results:

VINYL CHLORIDE PPB	BENZENE ppb	TOLUENE ppb	CO_2 PPM	O_2 %	CO PPM
< 20	< 7	20	506	21.0	0

preliminary draft report has been received from the ARB detailing their concentration d emission flux data results. This report may be found in the Source Test Engineering test report file. No results are available at this time on the work conducted by the Calif. Institute of Technology.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 54-485

Date 9-27 and 10-10-85

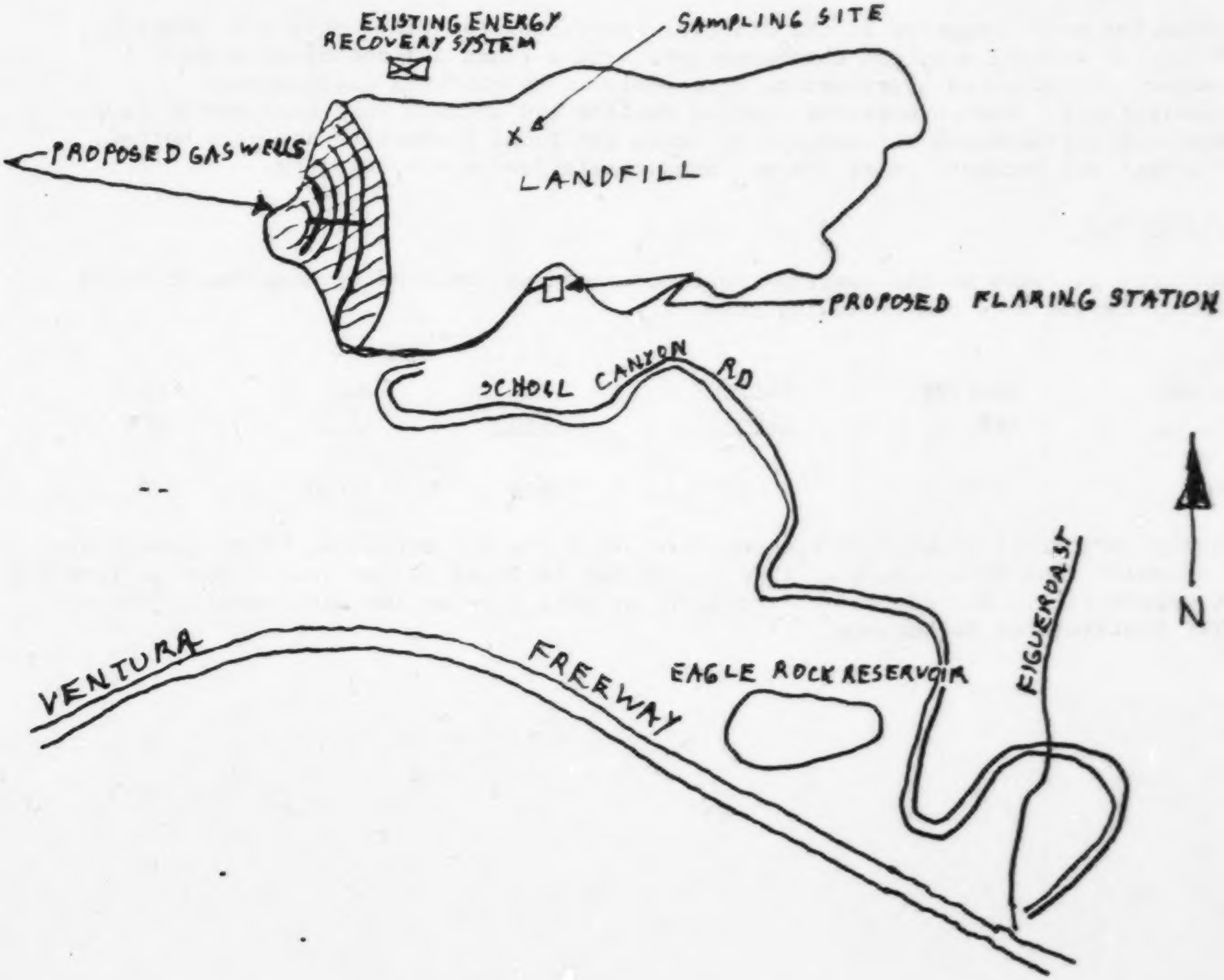

EXISTING ENERGY RECOVERY SYSTEM
SAMPLING SITE
PROPOSED GAS WELLS
LANDFILL
PROPOSED FLARING STATION
SCHOLL CANYON RD
N
FIGUEROA ST
VENTURA FREEWAY
EAGLE ROCK RESERVOIR

FIGURE 1. Scholl Canyon landfill site.

INTRODUCTION

On November 7, 1984, source test personnel from the South Coast Air Quality Management District (SCAQMD) collected landfill surface gas samples, obtained from the ARB Flux Sampling device (see 84-485) at L.A. County Scholl Canyon Landfill, Glendale.

The Scholl Canyon landfill is owned and operated by the Los Angeles County Sanitation District. This landfill has been operating as a Class II site from 1961 to the present time. It has an expected life to the year 2025. Landfill gas is generated from the biological decomposition of buried organic materials. There is no gas collection or recovery system available at this time, however a series of gas wells and a flaring station have been proposed.

SAMPLING AND ANALYTICAL PROCEDURES

Surface gas samples were obtained from three sites on the landfill (see FIGURE 1). The method of extracting the gas sample from the ARB Flux sample line was similar to that shown in FIGURE 2. A sample probe was inserted into the collection location and purged with gas sample using an aspirator bulb. The gas sample was then extracted with an evacuated 2-liter glass bulb.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, CO, CO_2, O_2 AND CH_4

All samples were submitted to the District Laboratory for vinyl chloride, benzene and toluene detection by gas chromatography with a flame, and photoionization detector. Chlorinated hydrocarbons were analyzed by electron capture/gas chromatography. Carbon monoxide, carbon dioxide and methane were analyzed by non-dispersive infrared/gas chromatography using the Total Combustion Analysis Method, and oxygen was obtained using thermal conductivity/gas chromatography.

The ARB used three analyzers to measure the total hydrocarbon and methane concentration in the Flux Box intake and exhaust sample lines. Two Beckman Model 400 FID instruments measured the inlet and outlet THC. A Bendix Model 8202 FID/GC was used to monitor CH_4 in the inlet and outlet lines by alternating between both lines.

TEST CRITIQUE

Laboratory analyses of the landfill surface emissions obtained by sampling with the ARB Flux device show the following results:

PT #	VINYL CHLORIDE (PPB)	CH_4 (PPM)	CO_2 (PPM)	O_2 (%)	CO (PPM)	APPROX. ARB THC (PPM)
3	57	856	1130	20.9	0	100-200
4	35	207	621	20.8	0	40-50
5	<10	70	537	20.9	0	50

Test No. 84-539 Date 11/7/84

Scholl Canyon

A preliminary draft report has been received from the ARB detailing their concentration and emission flux data results. This report may be found in the Source Test Engineering test report file (84-485). No results are available at this time on the work conducted by the California Institute of Technology.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 84-539

Date 11/7/87

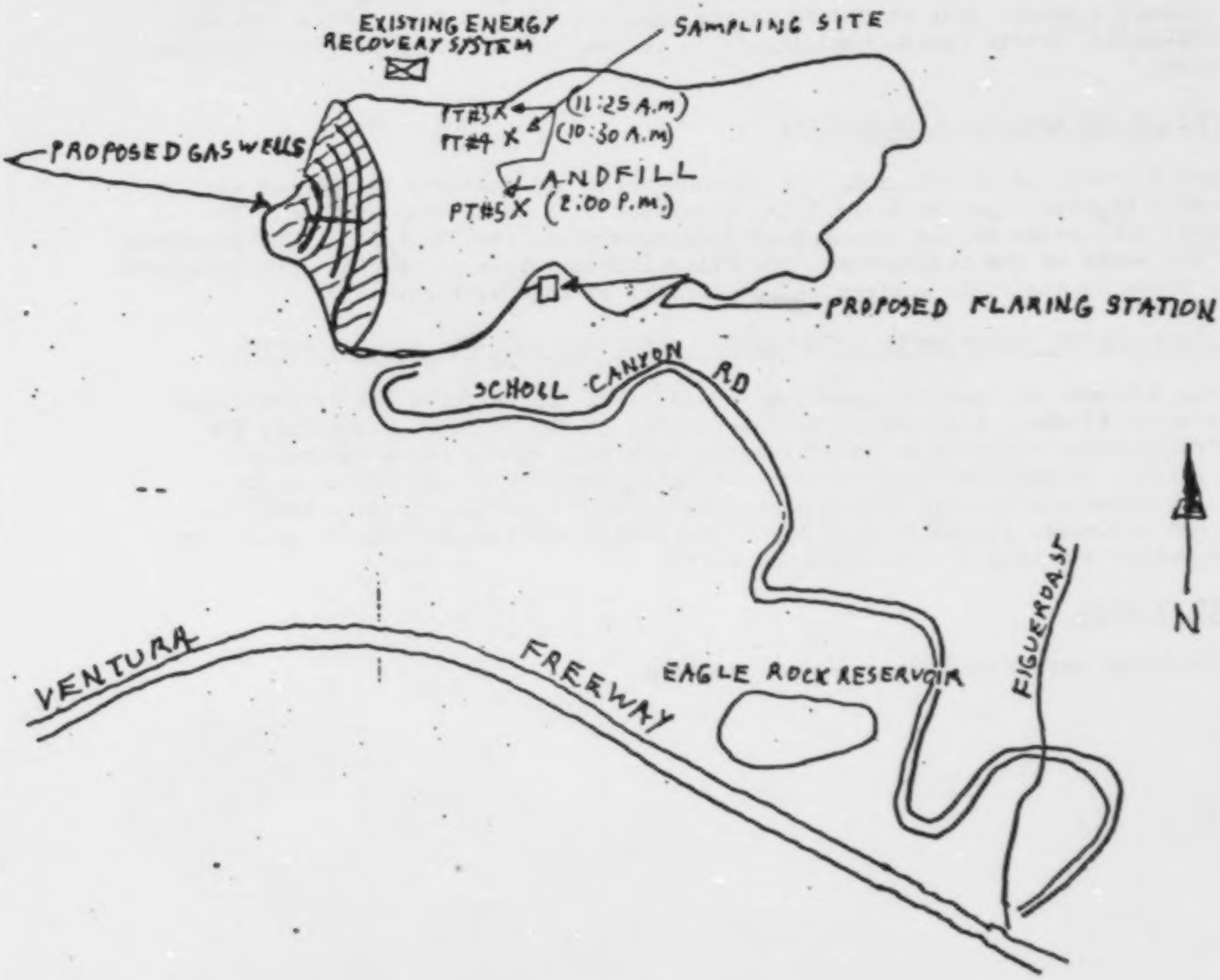

EXISTING ENERGY
RECOVERY SYSTEM
SAMPLING SITE
PT#3X
(11:25 A.m)
PT#4 X
(10:30 A.m)
PROPOSED GAS WELLS
LANDFILL
PT#5X (2:00 P.m.)
PROPOSED FLARING STATION
SCHOLL CANYON RD
N
VENTURA FREEWAY
EAGLE ROCK RESERVOIR
FIGUEROA ST

FIGURE 1. Scholl Canyon landfill site.

INTRODUCTION

On August 28, 1984, Messrs. J. Littman, P. Chavez from the Source Testing and Monitoring Branch of the South Coast Air Quality Management District (SCAQMD), performed a source test at Coyote Canyon Landfill, Bonita Canyon Road, Irvine, California. Coyote Canyon Landfill is an active landfill with no gas collection system.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill. The bucket collection method was used at locations where the OVA readings were highest on the scale of the instrument. The OVA measured values and bucket site locations are shown in the field surface survey sheet (see Page 4, Figure 1).

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization etector. Chlorinated hydrocarbons were analyzed by Electron Capture with a C. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

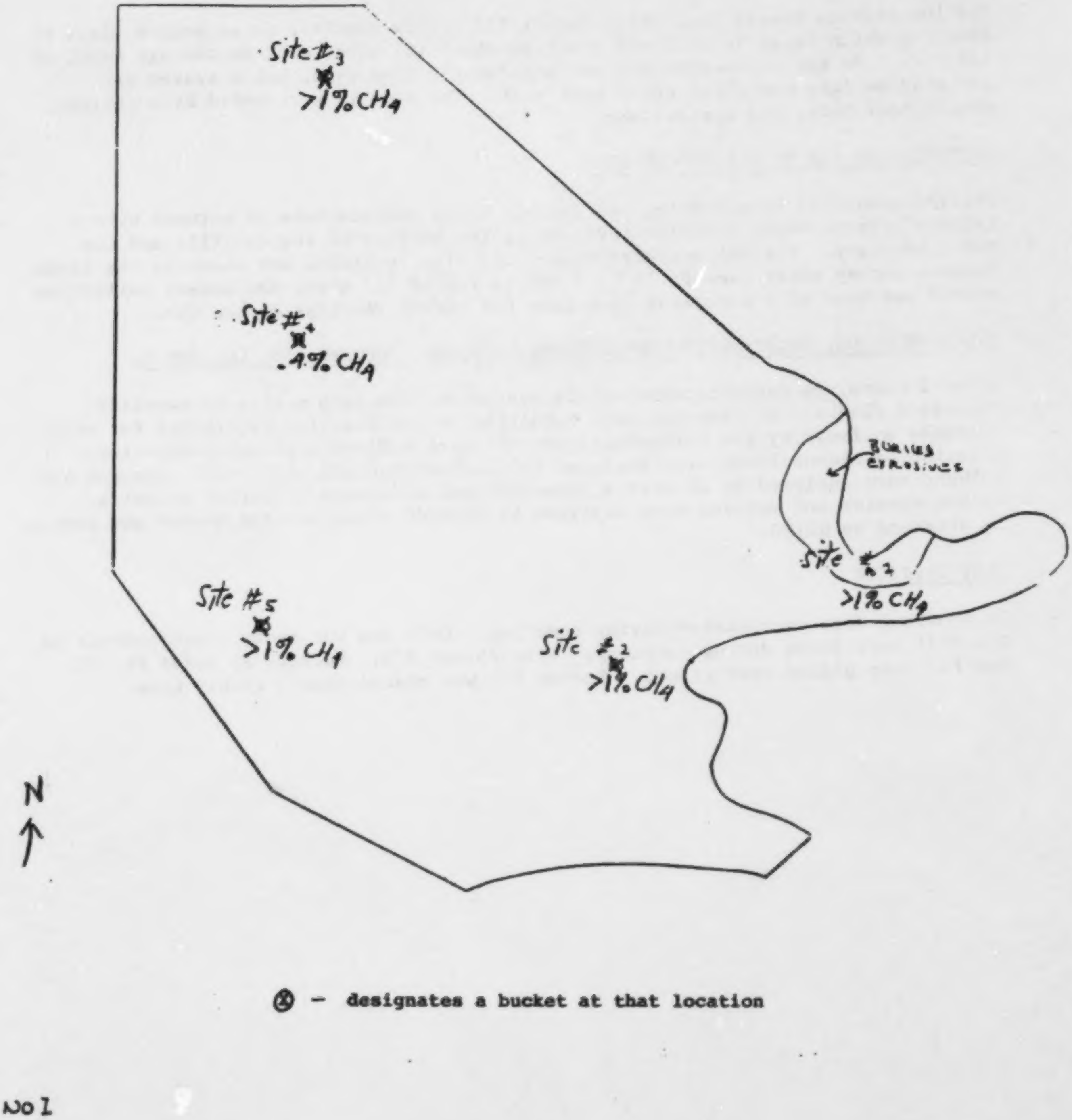
No problems were encountered during sampling.

84-444

Aug 28, 1985

COYOTE CANYON LANDFILL

Surface Survey Sheet


Site #3
>1% CH4
Site #4
.4% CH4
BURIED EXPLOSIVES
Site #1
>1% CH4
Site #5
>1% CH4
Site #2
>1% CH4
N

⊗ - designates a bucket at that location

Pic No I

LANDFILL DESCRIPTION

The Los Angeles County Sanitation District's Spadra landfill is an active class II landfill which began in 1957 and occupied about 130 acres with an average depth of 120 feet. No gas collection system is presently being used, but a system will probably go into operation early next year. The area is surrounded by a college, mobile home park, and agriculture.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill and its outer boundary. The OVA measured values and site locations are shown in the field surface survey sheet (see pg. # 5) and in FIGURE 1. Also, the bucket collection method was used at 4 locations that gave the highest readings on the OVA.

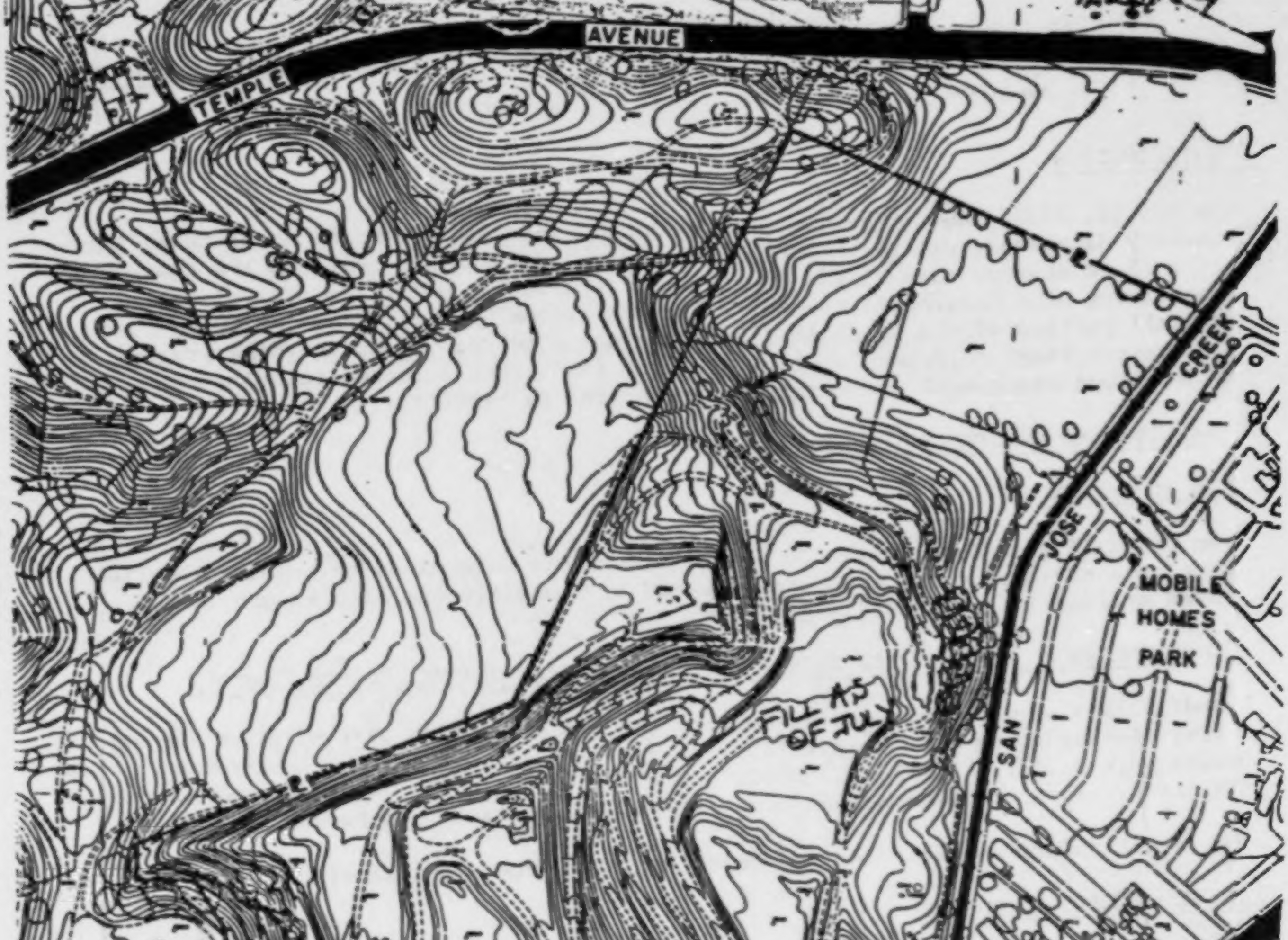
VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

No problems were encountered during sampling. Only two hot spots (highreadings on the OVA) were found during sampling; Site #5 and #10. Buckets at sites #4, #7, and #10 were placed over cracks. Bucket #11 was placed upon a gopher hole.

84-388 Spadra -5- 7/23/84


TEMPLE
AVENUE
SAN
JOSE
CREEK
MOBILE
HOMES
PARK
FILL AS OF JULY
VALLEY
BOULEVARD
N
R
R
R

Spadra

INTRODUCTION

On May 23, 1985, Source Testing and Monitoring personnel from the South Coast Air Quality Management District (SCAQMD), collected gas samples upstream and downstream of a flare station (See FIGURE I), connected to the landfill gas control system consisting of a horizontal trench collection system (see FIGURE II) serving just a small portion of the Landfill. Sampling was conducted as an on-going program to monitor vinyl chloride, benzene, toluene (and other selected chlorinated hydrocarbon compounds) concentrations generated in landfills.

SAMPLING AND ANALYTICAL PROCEDURES

GAS FLOW RATE

The Landfill gas inlet flow rate to the blower was determined by reading the flow rate on a circular chart recorder actuated by the differential pressure across a fixed orifice in the landfill gas pipe.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

andfill gas samples were collected from the gas collection system, prior to and fter flaring using evacuated 2-liter glass bulbs (FIGURE III). The contents of the bulbs were analyzed by FID/GC, EC/GC and PID/GC methods for determination of vinyl chloride, benzene, toluene, and other selected hydrocarbon compounds.

The vinyl chloride collection and emission rates were also calculated.

TOTAL ORGANIC COMPOUNDS

Sampling for total organic compounds (TOC) commenced for a continuous 20 to 25 minute period at the flare inlet and outlet using the method shown in FIGURE IV. Samples of effluent from the flare inlet and outlet were collected in eight-liter flasks. Heavier hydrocarbon compounds are deposited in dry ice-cooled traps prior to entering the flasks. Following standard Laboratory analysis, the amount of carbon compounds collected in the flasks and traps was compared to the volume of effluent sampled and reported with respect to concentration.

TEST CRITIQUE

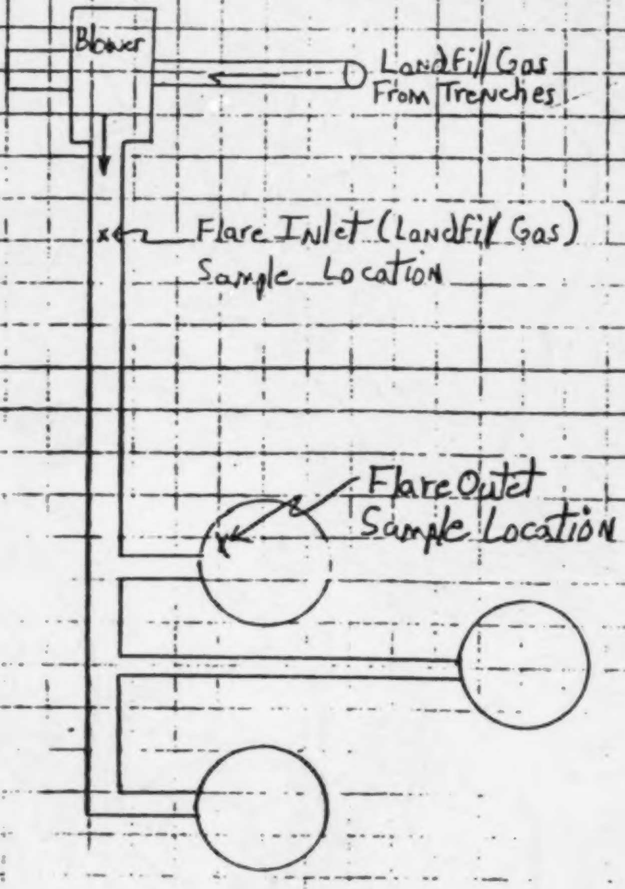
Gas sampling was conducted on a pre-scheduled bases during normal daylight hours with related equipment operating normally. No problems were encountered during sampling. Only 1 flare was in operation. Additional flares will be used after more gas collection trench systems are installed and well systems are installed.

5/23/85

Figure I

85-289

SPADRA LANDFILL
FLARE STATION


Blower
Landfill Gas From Trenches
Flare Inlet (Landfill Gas) Sample Location
Flare Outlet Sample Location

85.289 Spadra

Reproduced from best available copy.

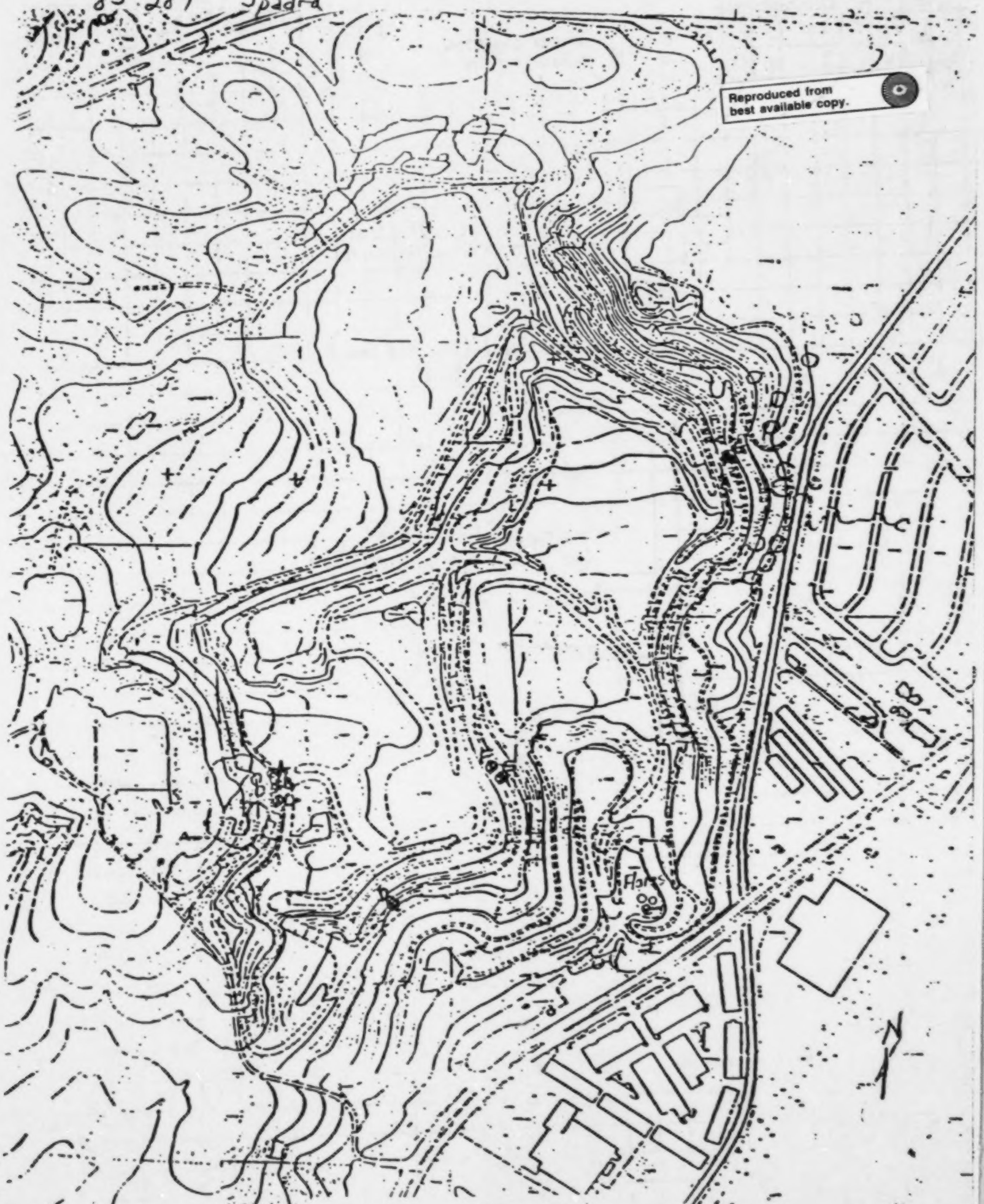


FIGURE II

LANDFILL DESCRIPTION

The City of Redlands Landfill is an active landfill for municipal wastes. There is no gas collection system for either the perimeter or interior of the landfill. It is surrounded by the City of Redlands waste water treatment plant, river bed, & an orange grove. The surface is flat with a river sand soft covering.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill and its outer boundary. The OVA measured values and site locations are shown in the field surface survey sheet in FIGURE I. Also, the bucket collection method (see FIGURE II) was used at 4 locations that gave the highest readings on the OVA.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2, AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

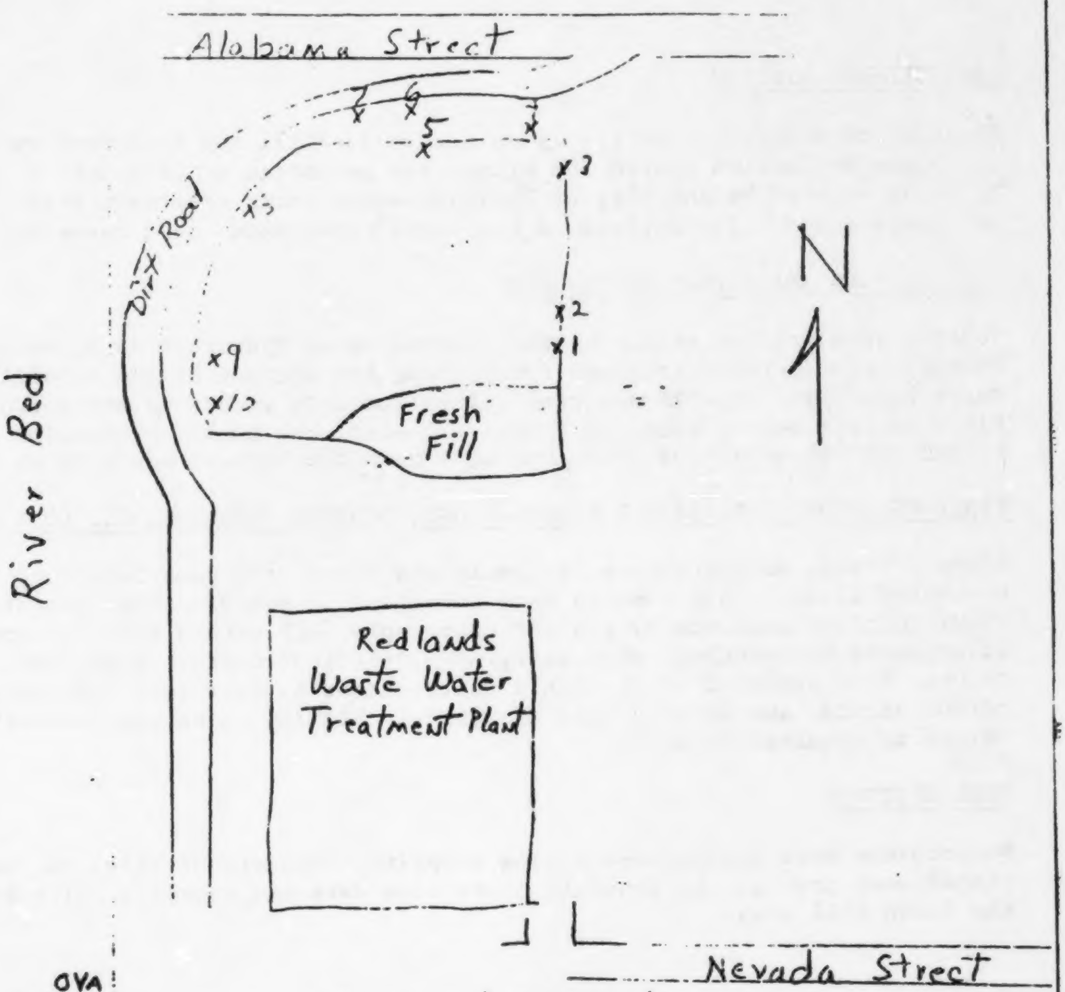
No problems were encountered during sampling. Buckets at sites #6, and #7 were placed over cracks. No landfill odors were detected, except at site #6, and at the fresh fill area.

5-1[illegible]
Figure #I

CITY OF REDLANDS

-7/12/[illegible]

Field Surface Survey
Using OVA & Bucket Collection


Alabama Street
7 x
6 x
5 x
x
x 3
x8
Dirt Road
x 2
x 1
x 9
x 10
Fresh Fill
N
River Bed
Redlands Waste Water Treatment Plant
Nevada Street

Bulb#
MNO
760
A
STU

Site #	OVA Methane ppm	Area and Comment
1	30	Upper Ridge
2	30	Upper Ridge
3	60	Slope - Near Upper Ridge
4	100	Slope - Near Upper Ridge
5	100	Slop - Near Upper Ridge
6	10,000	Slope - 5ft. up from Dirt Road (Bucket A)
7	3,000	Slope - 5ft. up from Dirt Road (Bucket B)
8	100	Upper Ridge (Bucket C)
9	100	Upper Surface - 3ft. from Ridge (Bucket D)
10	50	Upper Surface - 10ft. from Ridge

Site: Cover Surface of Top Lift Averaged Approx. 15 ppm.

INTRODUCTION

On October 9, 1985, personnel from the South Coast Air Quality Management District (SCAQMD) conducted a source test on several landfill gas collection wells located at TOYON CANYON LANDFILL - Los Angeles, California. The purpose of the test was to gather information on gaseous emissions from landfill containing only municipal waste.

EQUIPMENT AND PROCESS DESCRIPTION

Toyon Canyon Landfill is an 80 acre Class II site utilized for the disposal of municipal type refuse. It has a capacity of 16 million cubic yards, and is currently accepting waste.

Pacific Light Energy Systems is in the final stages of installing 114 gas collection wells to collect landfill gas. The gas will be used to fuel seven internal combustion engines to produce electricity. The electricity will then be sold to the local electrical utility.

FIGURE 1 shows the location of the gas collection wells that were sampled.

SAMPLING AND LABORATORY ANALYSIS

Samples were secured from five gas collection wells utilizing a "grab sampling" apparatus, consisting of a stainless steel probe, rubber tubing, a squeeze bulb, and a two-liter evacuated bulb, as shown in FIGURE 2.

The stainless steel probe was inserted into the top of the gas collection well. The sampling line was purged with the use of the squeeze bulb. A sample was then collected into the evacuated bulb.

An orifice with a magnehelic differential pressure gage was connected to the well to determine the static condition of the sampled wells.

All samples were analyzed for vinyl chloride utilizing gas chromatography with a flame ionization detector. Chlorinated hydrocarbons were determined by gas chromatography with electron capture. Benzene and toluene were determined by gas chromatography with a photoionization detector. Methane, non-methane hydrocarbons, carbon dioxide, and carbon monoxide, were determined by gas chromatography with a non-dispersive infrared detector.

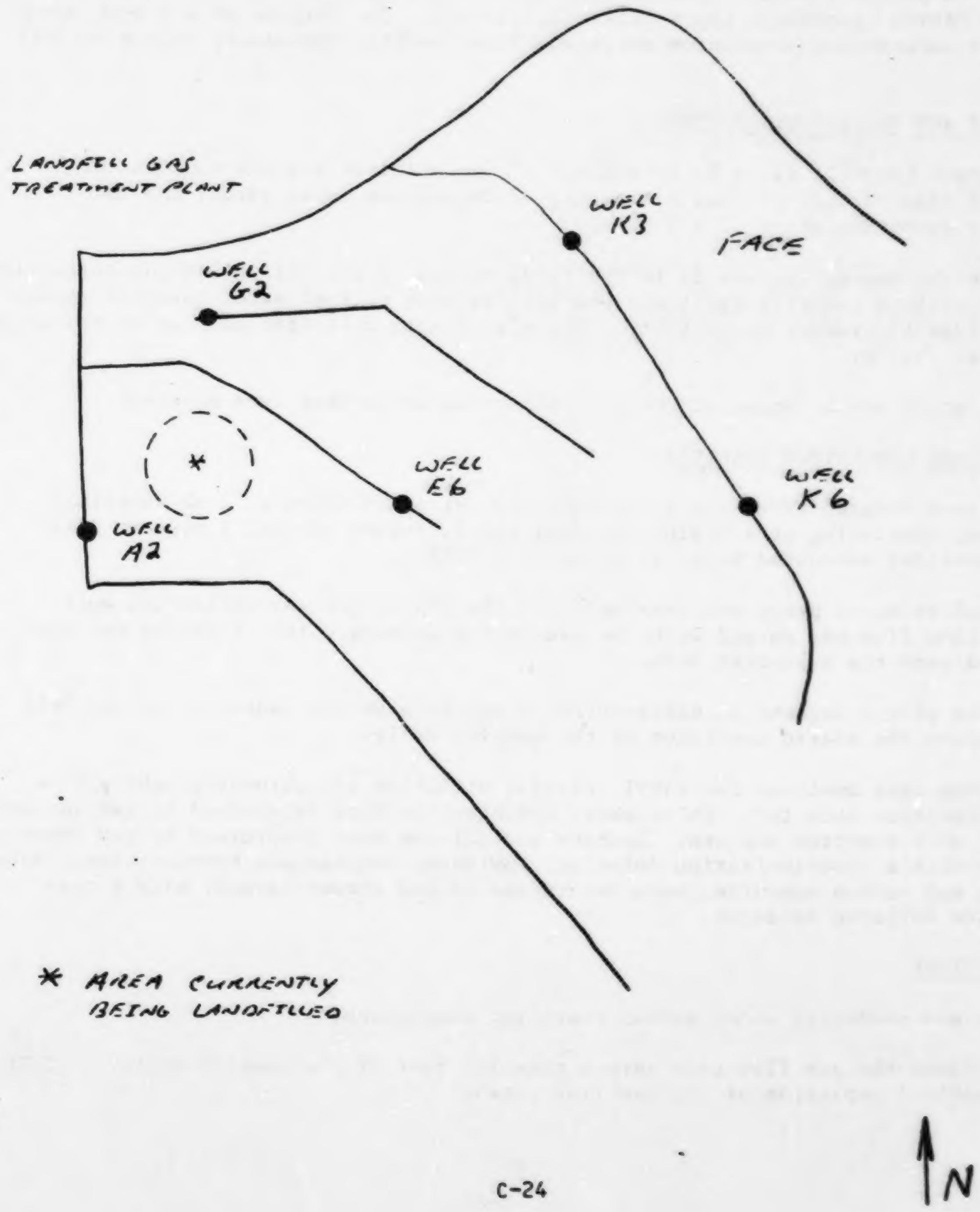
TEST CRITIQUE

The test was conducted under normal operating conditions.

TABLE 1 lists the gas flow rate versus time for four of the sampled wells. FIGURE 3 is a graphical depiction of the gas flow rates.

FIGURE 1

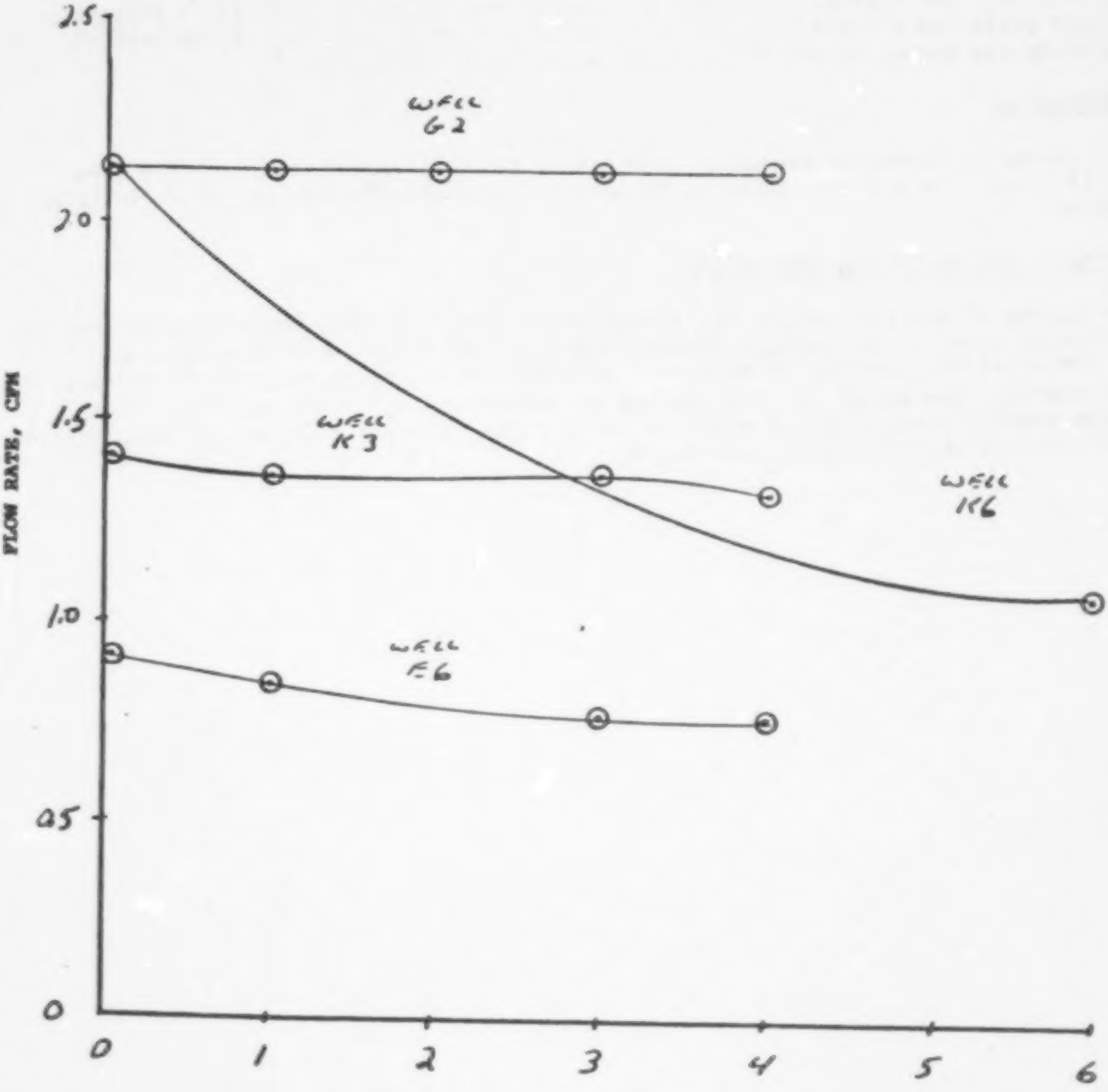
TOYON CANYON LANDFILL


LANDFILL GAS TREATMENT PLANT
WELL K3
FACE
WELL G2
WELL E6
WELL K6
WELL A2
*
* AREA CURRENTLY BEING LANDFILLED
N

85-507
Toyon Canyon

FIGURE 3

Well Flow Rate vs Time



INTRODUCTION

On July 27, 1984 Messrs. P. Chavez, E. Muehlbacher, of the SCAQMD Source Testing Branch performed a landfill gas surface emission survey at a landfill maintained by Riverside County Refuse Disposal Division. (see FIGURE NO. 1)

DESCRIPTION

The County of Riverside maintains an inactive landfill with a total surface area of 70 acres with a survey depth of 25 feet. At present their is no gas collection system.

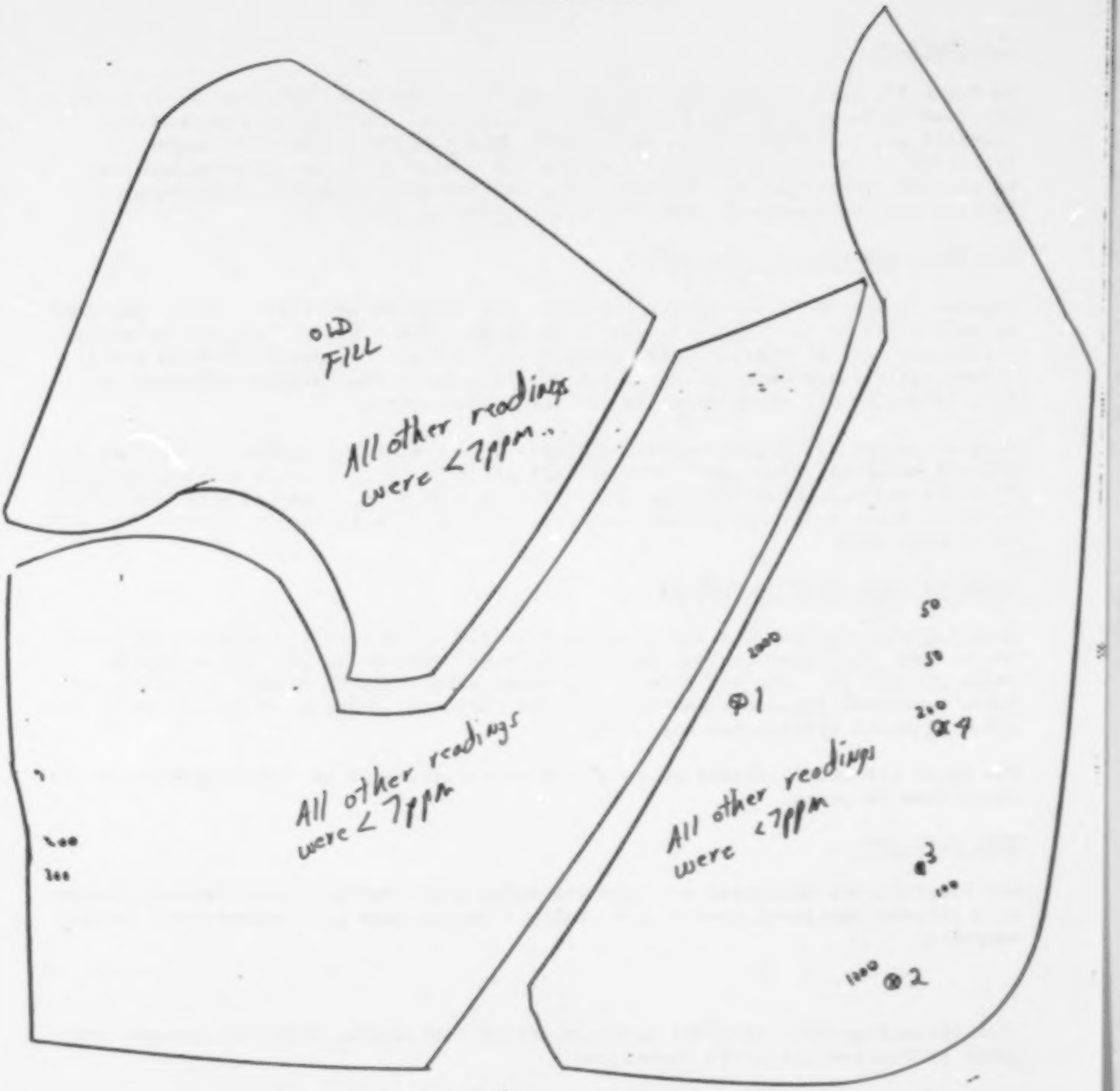
SAMPLING AND ANALYTICAL PROCEDURES

The survey of the surface gas was accomplished using a Century Organic vapor analyzer (O.V.A.). Most of the surface readings taken by the O.V.A. were on an average of 20 ppm total hydrocarbons as methane. Buckets were placed on areas where readings were the highest (see FIGURE 1), and allowed to stablized for 1 hour, and then 2-liter flask samples were taken and analyzed for CO, CO_2, O_2 vinyl cloride, benzene, toluene and selected chlorinated HC, non-CH_4 HC.

BW-402

7/27/84

WEST RIVERSIDE LANDFILL
(OVA Readings in ppm)


OLD FILL
All other readings were <7ppm..
All other readings were <7ppm
All other readings were <7ppm
200
200
2000
1
50
50
200
4
3
100
1200
2

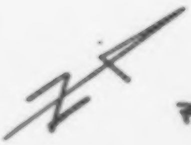


FIGURE NO 2

Bucket Location #	Bulb #
1	9601
2	8K
3	EH
4	TC

C-27

SOU COAST AIR QUALITY MANAGEMENT TRICT
9150 Flair Drive, El Monte, California 91731

Test No. C-84-200 Date 3/15/84

INTRODUCTION

On March 15, 1984, Source Testing and Monitoring personnel from the South Coast Air Quality Management District (SCAQMD), collected gas samples from selected landfill gas collection lines serving the Mountaingate and Mission Canyon Landfills in West Los Angeles. Sampling was conducted as an on-going program to monitor vinyl chloride, benzene, toluene (and other selected chlorinated hydrocarbon compounds) concentrations generated in landfills.

EQUIPMENT AND PROCESS DESCRIPTION

Mission Canyon and Mountaingate landfills are inactive landfills located adjacent to each other in the Sepulveda Pass area of West Los Angeles. Mountaingate was previously part of Mission Canyon (which is owned by Los Angeles County) until recent real estate development by private interest. Information collected at each landfill will be released in two, separate reports.

Mission Canyon and Mountaingate Landfills, like most other landfills, utilize a network of wells and vacuum assisted collection lines to extract gases generated from the decomposition of refuse. Consisting mostly of carbon dioxide and methane, these gases can be used as fuel for various purposes, or simply "flared", as in this case.

SAMPLING ANALYTICAL PROCEDURES

Landfill gas samples were collected at selected collection lines (see FIGURE 1) in the gas collection system, prior to flaring using evacuated 2-liter glass bulbs (FIGURE 2). The contents of the bulbs were analyzed by FID/GC, EC/GC and PID/GC* methods for determination of vinyl chloride, benzene, toluene, and other selected hydrocarbon compounds.

The vinyl chloride "collection rate" was also calculated at each sample point for comparison purposes.

TEST CRITIQUE

Gas Sampling was conducted on a pre-scheduled basis during normal daylight hours with related equipment operating normally. No problems were encountered during sampling.

---

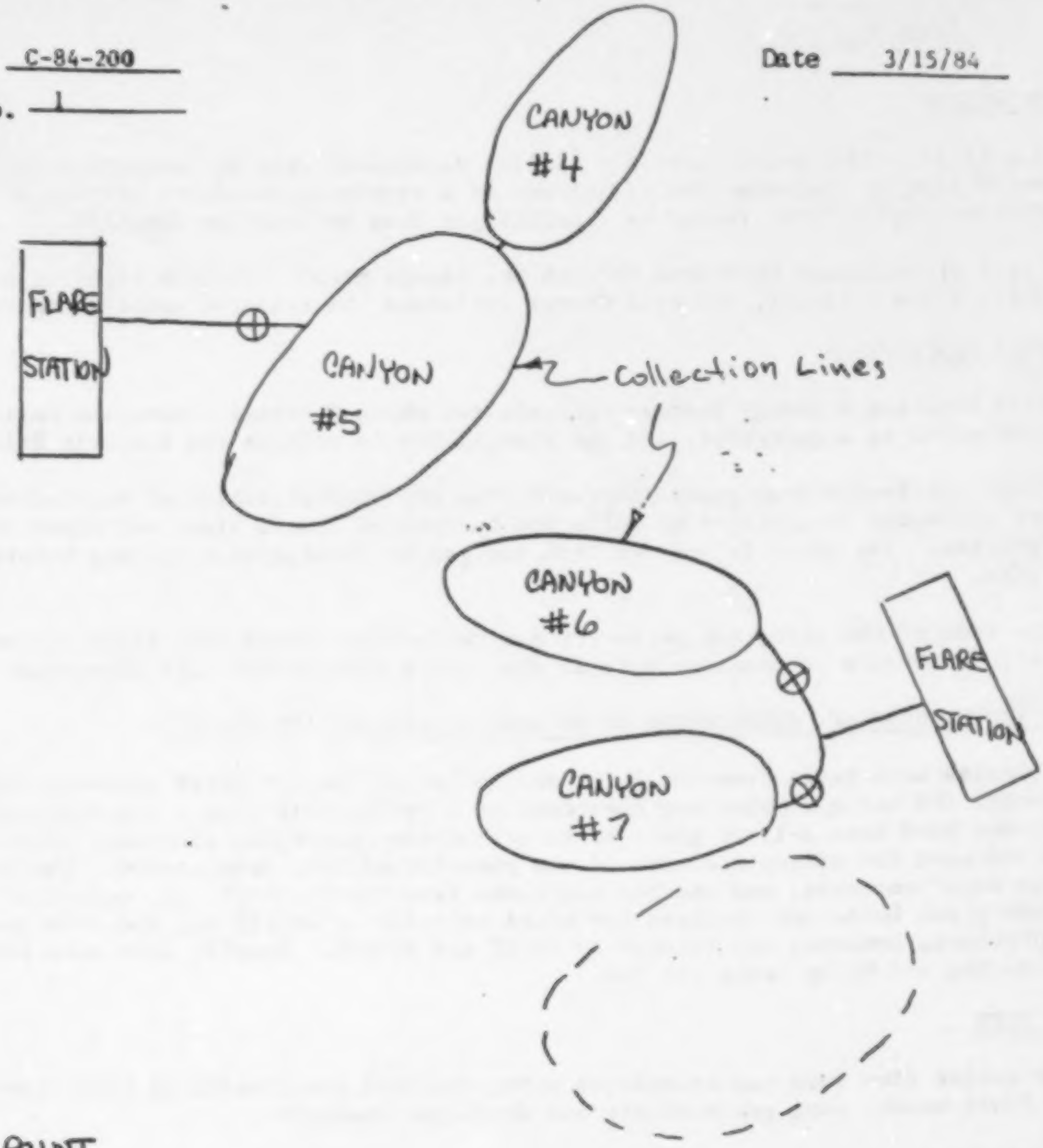
*Gas Chromatographic analysis involving flame ionization, electron capture, and photo ionization detection techniques

SOUTH COAST AIR QUALITY MANAGMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. C-84-200

Date 3/15/84

Figure No. 1


CANYON #4
FLARE STATION
CANYON #5
Collection Lines
CANYON #6
FLARE STATION
CANYON #7

⊗ SAMPLE POINT

MOUNTAINGATE LANDFILL
2201 N. Sepulveda Blvd.
West Los Angeles, CA.

st No. 84-439 Date 8/24/84

Upland

INTRODUCTION

On August 24, 1984, South Coast Air Quality Management District personnel conducted a source test to determine the efficiency of a catalytic converter serving an Internal Combustion Engine (ICE) fueled by landfill gas from an inactive landfill.

The test arrangements were made through Mr. Dennis Marsh - Pacific Lighting & Energy Systems; Steve Marinoff, and Paul Chavez performed the required sampling operations.

PROCESS DESCRIPTION

Pacific Lighting & Energy Systems operates two White Internal Combustion Engines (ICE), each attached to a generator, and the electricity is sold to the Electric Utilities.

The ICEs are fueled from gases generated from the biodegradation of burried organic refuse collected by underground wells and horizontal trench lines and piped to the ICE station. The water is removed from the gas by refrigerated cooling before use by the ICEs.

At the time of the test, the perimeter gas collection system with flare was not operating, because it operates only in the early morning and late afternoon.

NO$_x$, VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE AND TOLUENE

Gas samples were taken from the inlet and outlet of the catalytic converter serving the south ICE using a Mylar bag connecter to a peristaltic pump. The contents of the bags were bled into 2-liter glass bulbs containing H_2O_2-H_2SO_4 absorbing solution, then analyzed for nitrogen oxides of the phenoldisulfonic acid method. The remainder of the bags' contents, and another bag taken from the landfill gas, were bled into 2-liter glass bulbs and analyzed for vinyl chloride by GC/FID and for chlorinated hydrocarbons, benzene, and toluene by EC/GC and FID/GC. Samples were also analyzed for CO, CO_2 and O_2 by using the TCA.

FLOW RATE

Stack outlet flow rate was calculated using the fuel gas (landfill) flow rate taken by a Roots meter, fuel gas analysis and stack gas analysis.

TEST CRITIQUE

The #1 ICE ran normally during the test period. No gas velocity was taken due to the extreme heat given off at the exhaust stack and limited scaffolding.

The ICE's are owned by Rhodes & Associates. The landfill is owned by the City of Upland.

84-439

CITY OF UPLAND

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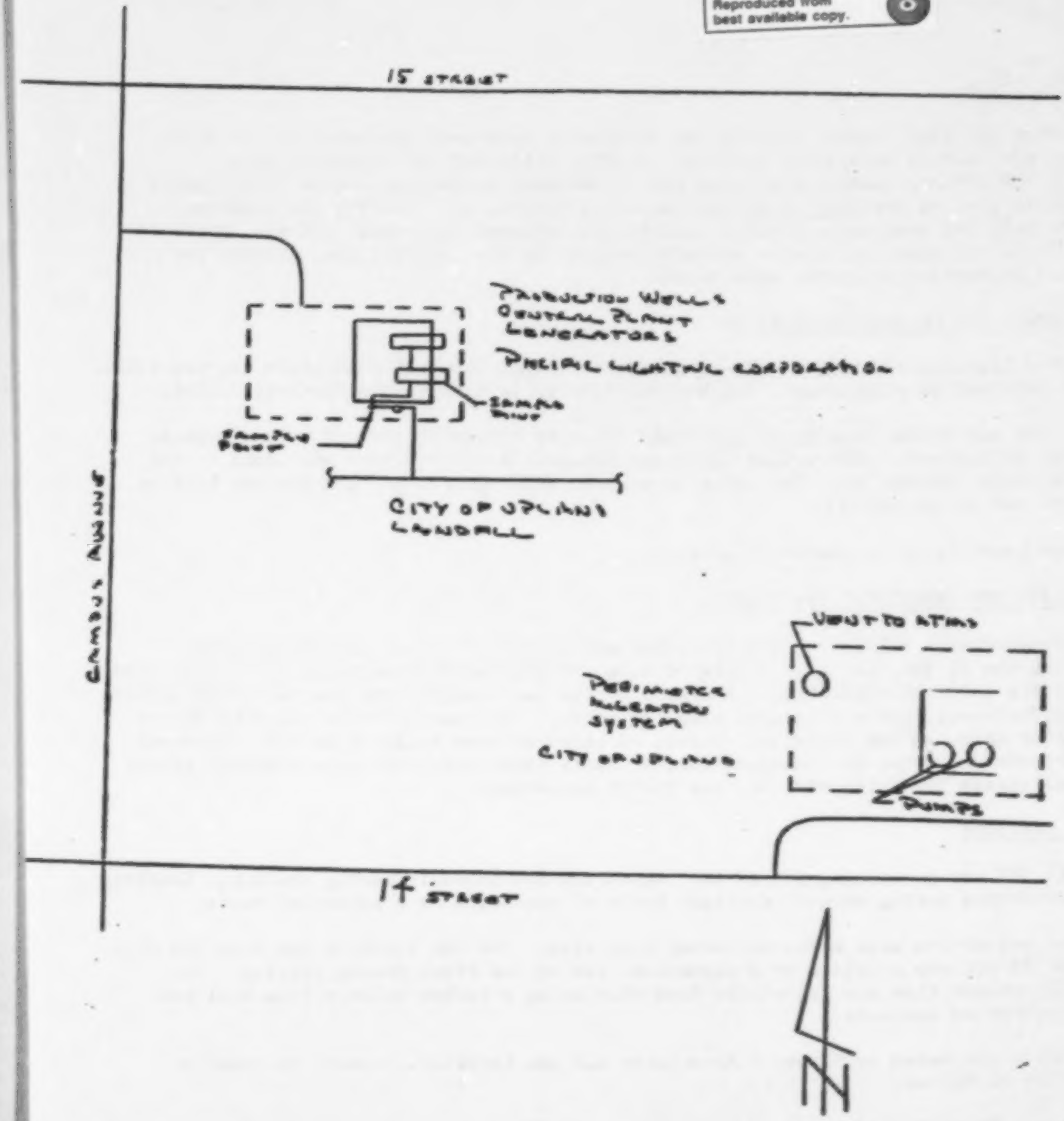

15 STREET
PRODUCTION WELLS
CENTRAL PLANT
GENERATORS
PACIFIC LIGHTING CORPORATION
SAMPLE POINT
SAMPLE POINT
CITY OF UPLAND
LANDFILL
CAMPUS AVENUE
VENT TO ATMS
PERIMETER
MIGRATION
SYSTEM
CITY OF UPLAND
PUMPS
14 STREET
N

FIGURE NO 2

INTRODUCTION

On March 28, 1985, Source Testing and Monitoring personnel representing the South Coast Air Quality Management District (SCAQMD) collected gas samples from a catalytic exhaust converter serving the #2 internal combustion engine (ICE) fueled by landfill gas, at the City of Upland Landfill, Upland, CA. Testing was conducted as an on-going program to monitor specific chlorinated compounds, toluene, benzene, oxides of nitrogen, and carbon monoxide present in the landfill gas, itself, and in its combustion products, when burned.

EQUIPMENT AND PROCESS DESCRIPTION

Pacific Lighting & Energy Systems operates two White Internal Combustion Engines (ICE), each attached to a generator, and the electricity is sold to the Electric Utilities.

The ICEs are fueled from gases generated from the biodegradation of buried organic refuse collected by underground wells and horizontal trench lines and piped to the ICE station (FIGURE 1). The water is removed from the gas by refrigerated cooling before use by the ICE's.

Upland Landfill is an inactive landfill.

SAMPLING AND ANALYTICAL PROCEDURES

Gas samples were collected from the inlet and outlet of the catalytic converter serving the #2 ICE, using an aspirator bulb and evacuated glass bulbs containing PDS* absorbing solution (FIGURE 2). A sample of the raw landfill gas was collected, prior to conditioning, using a similar sampling method. All samples were returned to the District Chem Lab for analysis. Oxides of nitrogen were analyzed by SIE. Selected chlorinated hydrocarbon compounds (particularly vinyl chloride) were analyzed by gas chromatograph involving FID, EC, and PID*** detection.

TEST CRITIQUE

The #2 ICE was generating 225 KW and operating continuously during testing. Sampling was conducted during normal, daylight hours of operation on a scheduled basis.

No gas velocities were measured during this test. The raw landfill gas flow (60 CFM) to the #2 ICE was provided by a representative of the Plant during testing. The #2 ICE exhaust flow was calculated from this using a carbon balance from fuel gas and combustion analyses.

The ICE's are owned by Rhodes & Associates and the Landfill, itself, is owned by the City of Upland.

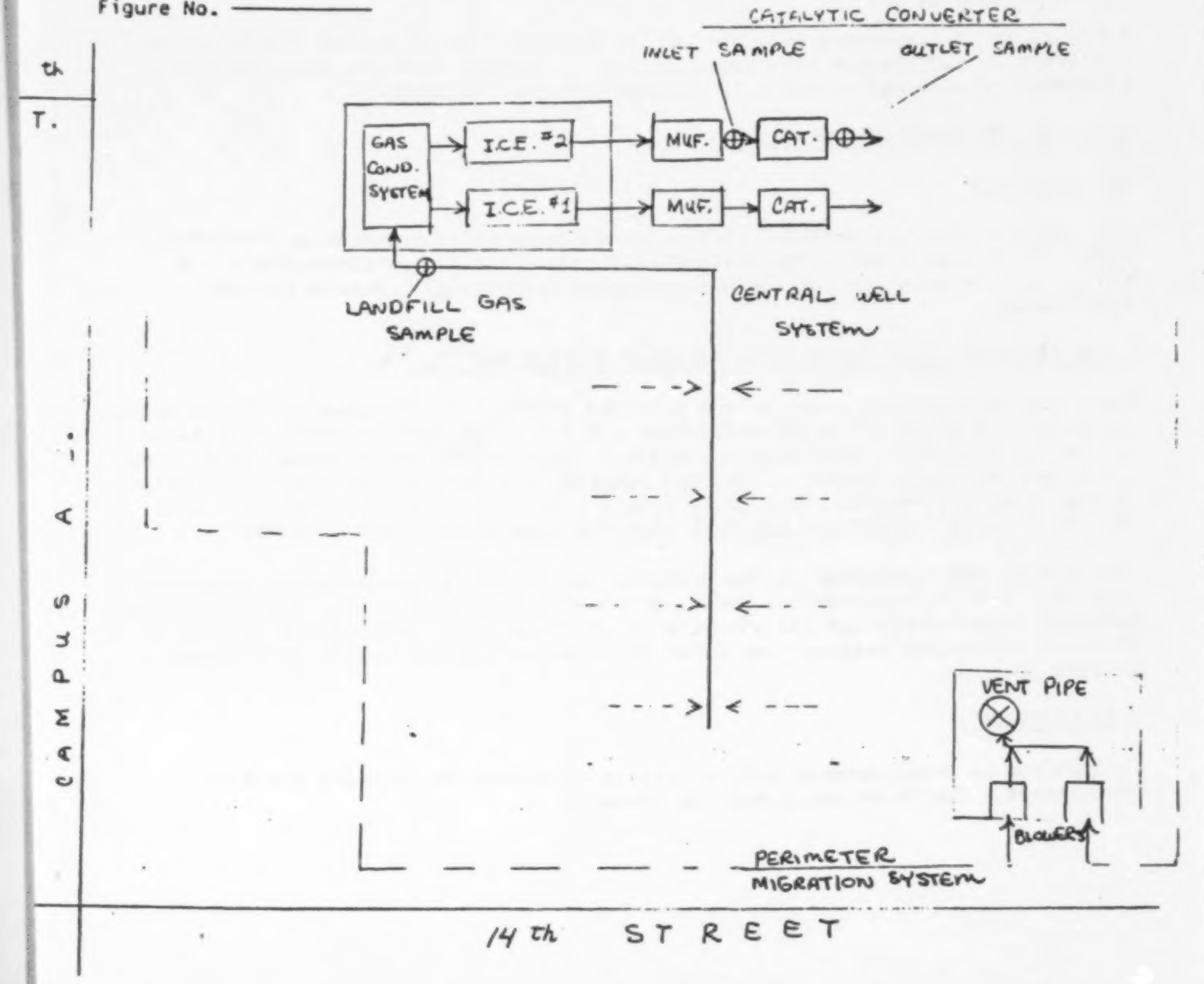
* PDS - Phenoldisulfonic Acid
** SIE - Selective Ion Electrode
*** FID, EC, PID - Flame Ionization Detection, Electron Capture, and Photoionization Detection.

SOUTH COAST AIR QUALITY MANAGMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 85/128

Date 3/28/85

Figure No. ________


CATALYTIC CONVERTER
INLET SAMPLE
OUTLET SAMPLE
GAS COND. SYSTEM
I.C.E. #2
I.C.E. #1
MUF.
CAT.
MUF.
CAT.
LANDFILL GAS SAMPLE
CENTRAL WELL SYSTEM
VENT PIPE
BLOWERS
PERIMETER MIGRATION SYSTEM
14th STREET
CAMPUS A.
th
T.

CITY OF UPLAND LANDFILL
Internal Combustion Engine Fuel Collection and Control System

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 85-65
Valley Reclamation

Date 2/8/85

EQUIPMENT DESCRIPTION

Landfill gas is generated from biological decomposition of buried organic refuse. A battery of two blowers draw gases through a monifold from the underground gas collection system and exhausts it through a flare. (FIGURE 2).

SAMPLING AND ANALYTICAL PROCEDURES

GAS FLOW RATE

The gas flow rate was measured at the inlet sample point by velocity traverse using an "S" type Pitot tube, a Magnehelic gage and a K type thermocouple and Minimite. The moisture content was estimated from the gas composition and temperature.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE AND TOLUENE

Duplicate samples were taken at the velocity traverse point (inlet to flare) using evacuated two liter flasks directly from the duct. Duplicate samples were taken at the flare outlet stack using a stainless steel tubing and a squeeze bulb, into evacuated two liter flasks for CO, VC, benzene, toluene. At the outlet and inlet of the stack gas samples using a TCA tray FIGURE 1 was taken for analysis of CO_2, CO, CH_4 and O_2%. (ONLY ONE TANK AND TRAP WAS USED AT EACH SAMPLE POINT)

The samples were submitted to the District Laboratory for analysis and detection of CO_2, CH_4, non-CH_4 hydrocarbons and O_2 by the TCA Method and GC-Thermal Conductivity Detector respectively and for analysis of vinyl chloride, benzene and toluene by GC-Flame Ionization Detector and other chlorinated hydrocarbons by GC-Electron Capture Detector.

TEST CRITIQUE

No problems were encountered during testing or during the velocity traverse measurement. The flare was operating normally.

[illegible] DISTRICT
[illegible], El Monte, California 91731

85-65

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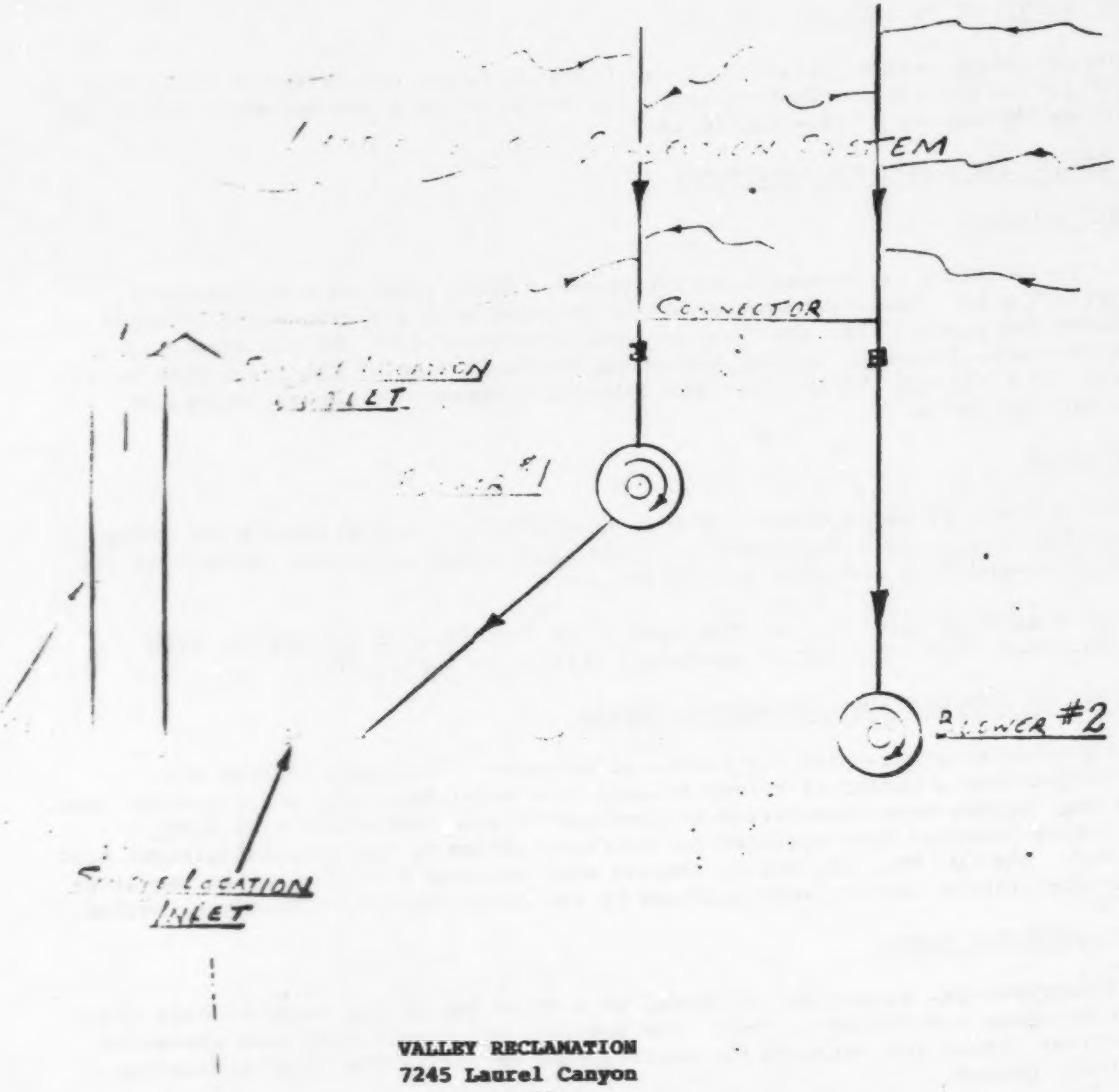
Date 2-8-85


[illegible] SYSTEM
CONNECTOR
B
B
SAMPLE LOCATION
OUTLET
BLOWER #1
BLOWER #2
SAMPLE LOCATION
INLET

VALLEY RECLAMATION
7245 Laurel Canyon
Sun Valley

FIGURE 2.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 84-372 — 4 — Date 7/10/84
Sheldon, Arleta

EQUIPMENT AND PROCESS DESCRIPTION

The equipment tested consisted of two flare stations, one connected to a interior gas collection system (Sheldon St.), and the other to a gas migration collection system (Wickes St.) (see FIGURE I).

SAMPLING AND ANALYTICAL PROCEDURES

GAS FLOW RATE

The gas velocity was measured with a standard Pitot tube and a differential pressure gage. The gas temperature was measured with a thermocouple potentiometer instrument. The gas flow rate was determined from the gas velocity, temperature, pressure, density and cross sectional area of the inlet pipe to each flare serving the interior gas collection system and the gas migration collection system.

ORGANICS

Organic material samples were taken at the outlet of each flare station using sampling trains, each consisting of a stainless-steel cold trap immersed in dry ice, followed by a ten-liter stainless tank.

Samples were analyzed by the "TCA method" as described in Los Angeles APCD Publication "Total Combustion Analysis" printed in August 1974.

OXIDES OF NITROGEN AND CARBONACEOUS MATTER

Flare outlets were sampled for oxides of nitrogen. These gas samples were collected over a period of twenty minutes in a Mylar bag using a Peristaltic pump. The bag samples were transferred to two-liter flasks containing H_2O_2-H_2SO_4 absorbing solution then analyzed for nitrogen oxides by the Phenoldisulfonic Acid Method. And CO, CO_2, CH_4 and O_2 samples were obtained from the bag in two-liter evacuated flasks samples were analyzed by the total combustion analysis method.

INTEGRATED GAS SAMPLE

An integrated gas sample was collected in a Mylar bag at the inlet of each flare station using a Peristaltic pump. The samples were transferred into evacuated two-liter flasks and analyzed for carbonaceous matter by the total combustion analysis method.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

Test No. 84-372 -5- **Date** 7/10/84

Sheldon, Arleta

TEST CRITIQUE

The equipment ran normally during the test period. No problems encountered.

See Laboratory report for concentrations of vinyl chloride, selected chlorinated hydrocarbons, benzene and toluene.

Flow rates for the outlet of the flare's were calculated, due to the extreme danger of heat from the flare outlets, using inlet flows and % CO_2 dry concentration.

84-372
7/10/84

- 6 -

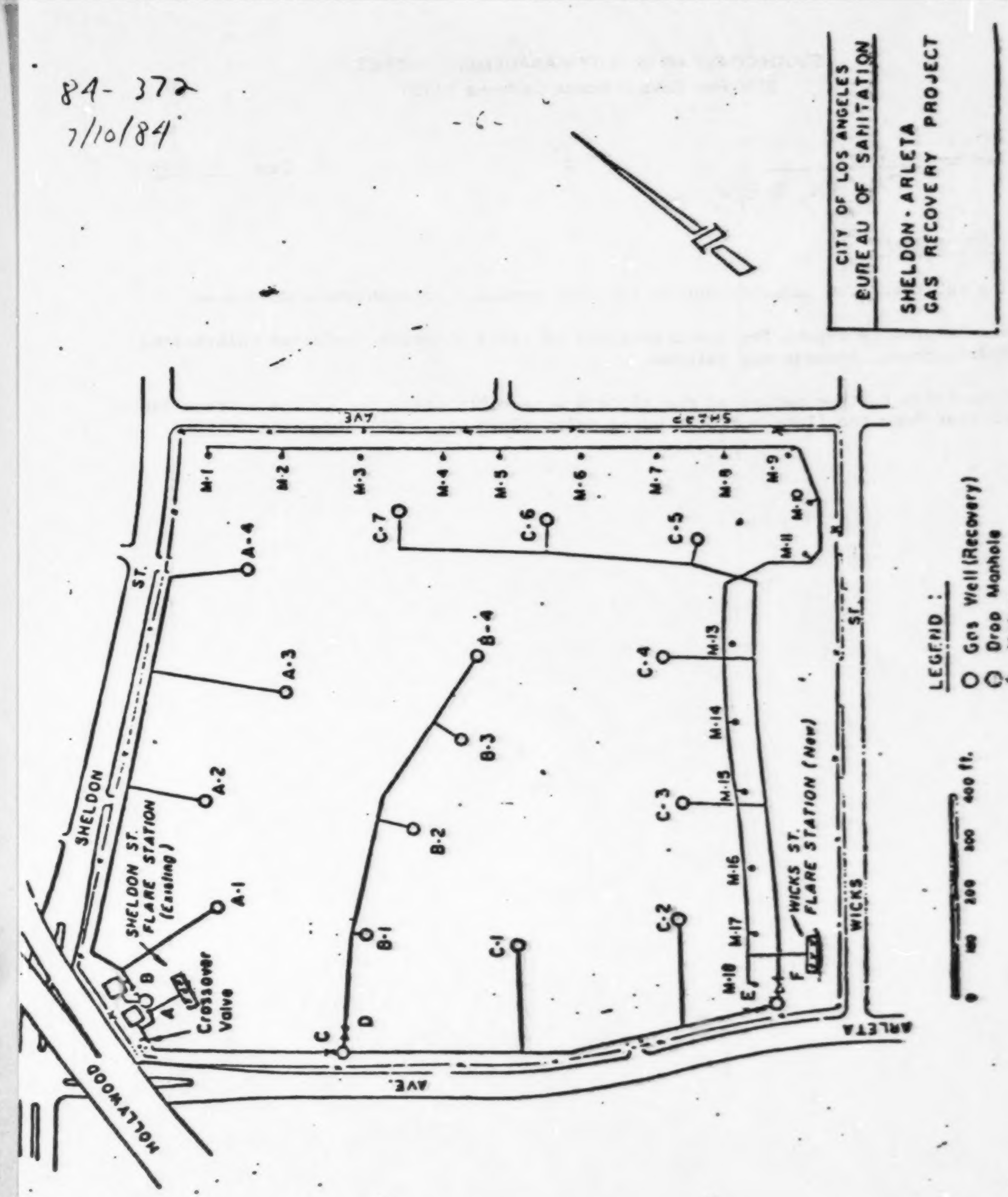

CITY OF LOS ANGELES
BUREAU OF SANITATION
SHELDON - ARLETA
GAS RECOVERY PROJECT
SHELDON ST.
ARLETA AVE.
WICKS ST.
HOLLYWOOD
SHELDON ST. FLARE STATION (Existing)
WICKS ST. FLARE STATION (New)
Crossover Valve
A
B
C
D
E
F
A-1
A-2
A-3
A-4
B-1
B-2
B-3
B-4
C-1
C-2
C-3
C-4
C-5
C-6
C-7
M-1
M-2
M-3
M-4
M-5
M-6
M-7
M-8
M-9
M-10
M-11
M-13
M-14
M-15
M-16
M-17
M-18
LEGEND :
Gas Well (Recovery)
Drop Manhole
Valve
Deep Migration Control Wells
0
100
200
300
400 ft.

FIGURE I

LANDFILL DESCRIPTION

The Kobra Landfill is a Class II inactive landfill that was closed in 1972. There is no gas collection system for either the perimeter or interior of the landfill. It is surrounded by industrial and open storage facilities. The surface is flat with a crushed rock hard covering. The northern part of the old landfill is now owned by Don Copp Crushing Company and is used for open-storage of crushed cement and asphalt. The southern part of the landfill is now owned by Don Trezler and used for freight trucks dispatching and has a loading dock boardering the daylight boundary area, and a truck repair shop stroddling the daylight boundary area of the landfill.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill and its outer boundary. The OVA measured values and site locations are shown in the field surface survey sheet in FIGURE 1. Also, the bucket collection method was used at 4 locations that gave the highest readings on the OVA.

NYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2, AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

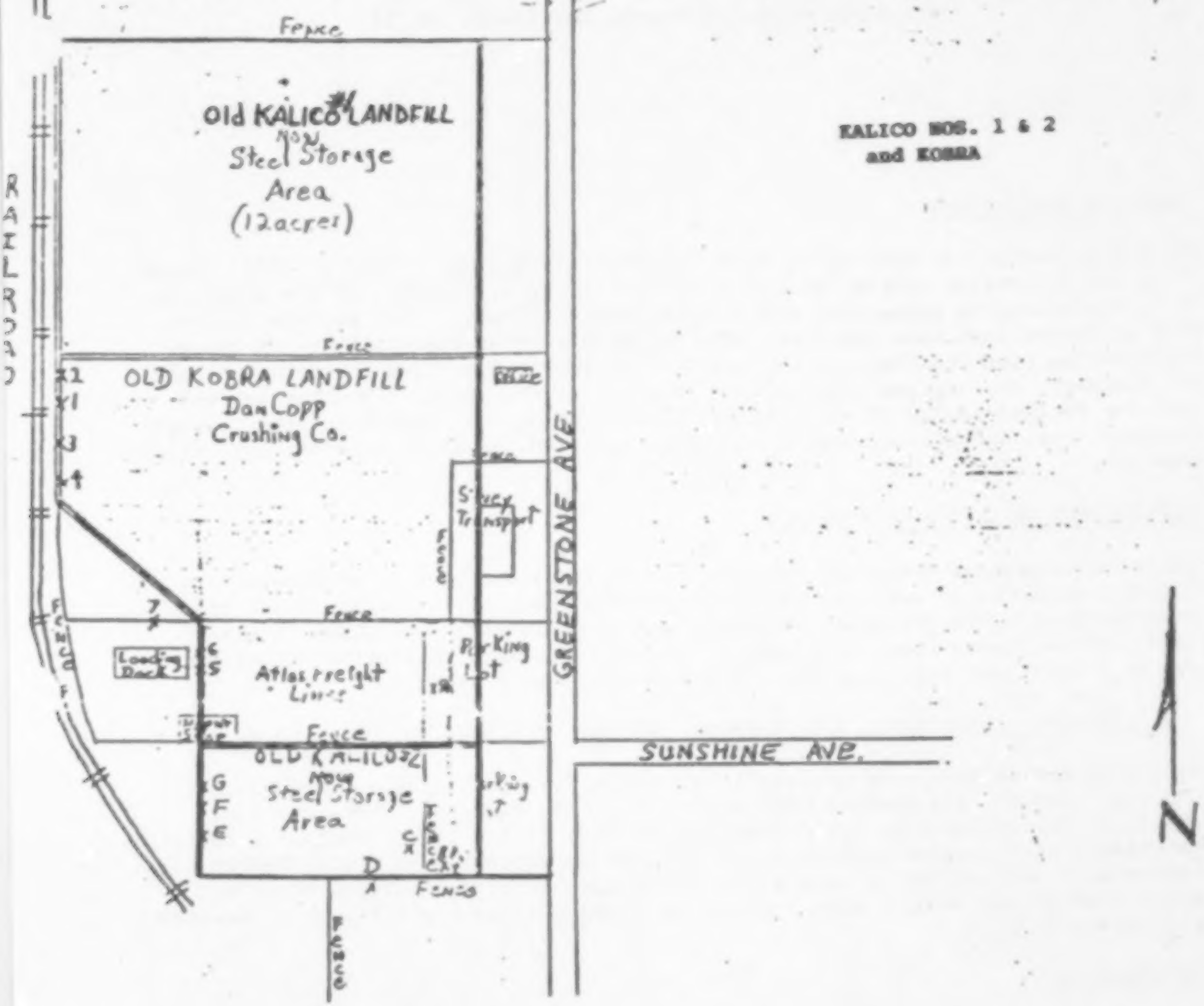
TEST CRITIQUE

No problems were encountered during sampling. Buckets at sites #4, #6, and #8 were placed over cracks. No landfill odors were detected except at site #8.

#84-478

Test Date 9/21/84

**KALICO NOS. 1 & 2
and KOBRA**


Fence
OLD KALICO #1 LANDFILL
Now
Steel Storage
Area
(12 acres)
RAILROAD
Fence
OLD KOBRA LANDFILL
Dan Copp
Crushing Co.
1
2
3
4
Steel Transport
Fence
GREENSTONE AVE.
7
Fence
6
5
Loading Dock
Atlas Freight Lines
Parking Lot
8
Fence
OLD KALICO #2
Now
Steel Storage
Area
G
F
E
D
A
Parking Lot
Fence
SUNSHINE AVE.
N

Pt. #	Methane ppm	Area and Comment
1	1000 +	Near R.R. Tracks on flat ground (crack) near slope of R.R. Tracks
2	1000 +	Near R.R. Tracks on flat ground (crack) near slope of R.R. Tracks.
3	1000 +	Near R.R. Tracks on slope
4	1000 +	Near R.R. Tracks
5	1000 +	20 ft. in front of dock at edge of buried cement
6	1000 +	10 ft. in front of dock on asphalt slope crack
7	1000 +	Dirt wall at fence
8	1000 +	Auto Parking lot crack

INTRODUCTION

On October 11, 1984, source testing personnel from the South Coast Air Quality Management District (SCAQMD) surveyed the surface area and collected surface gas samples from the Bill Burton ranch residence, located at the intersection of Gilmour Rd. and Byfield Rd. on the Gilmour Mud Sump (FIGURE 1 & 2). The mud sump had been operated as a Class II site and was closed in 1972. It has a capacity of 24,000 yds^3 and extends over 5 acres. The landfill served to store mud that had been used to lubricate oil drill rigs. This site is one of twenty landfills selected for a study under an EPA grant to the District.

Mr. Burton informed us that he purchased the property from Ken Cottongin approximately seven years ago; the original owner was Ben Gilmour. Bill Burton informed us that he learned about the property's history, after purchasing a portion of the site and building a residence. The oil-mud material dumped, was reported to have been excavated prior to Mr. Burton's acquisition of the property. However, Mr. Burton reports that he has located several spots showing oil contamination on his property.

MPLING AND ANALYTICAL PROCEDURES

A Century Model OVA 108 was used to measure surface total hydrocarbon (as CH_4) concentrations over the 2 1/3 acre Burton ranch. Mr. Burton used his tractor to dig a 3 ft. deep hole, in order that we might directly sample the gas emissions from the oil colored soil. Gas samples were collected, using the bucket collection method from the exposed soil.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, CO, CO_2, O_2 and CH_4

After 20 minutes, instantaneous samples were taken from the bucket using 2, two-liter evacuated flasks.

All the samples were submitted to the District Laboratory for vinyl chloride, benzene and toluene detection by gas chromatography with flame and Photo-ionization detectors. Chlorinated hydrocarbons were analyzed by electron capture/gas chromatography. Carbon monoxide, carbon dioxide and methane were analyzed by non-dispersive infrared/gas chromatography using the Total Combustion Analysis method, and oxygen was obtained using thermal conductivity/gas chromatography.

TEST CRITIQUE

Land surface hydrocarbon measurements taken using the OVA instrument showed extremely low background readings i.e. approximatley 1 ppm methane.

Laboratory analyses of the mud sump emissions, obtained by sampling 3 ft. below the top soil surface, produced the following results.

inyl aloride PPB	Benzene PPB	Toluene PPB	CO_2 PPM	CH_4 PPM	O_2 %
<20	66	135	4270	5105	20.4

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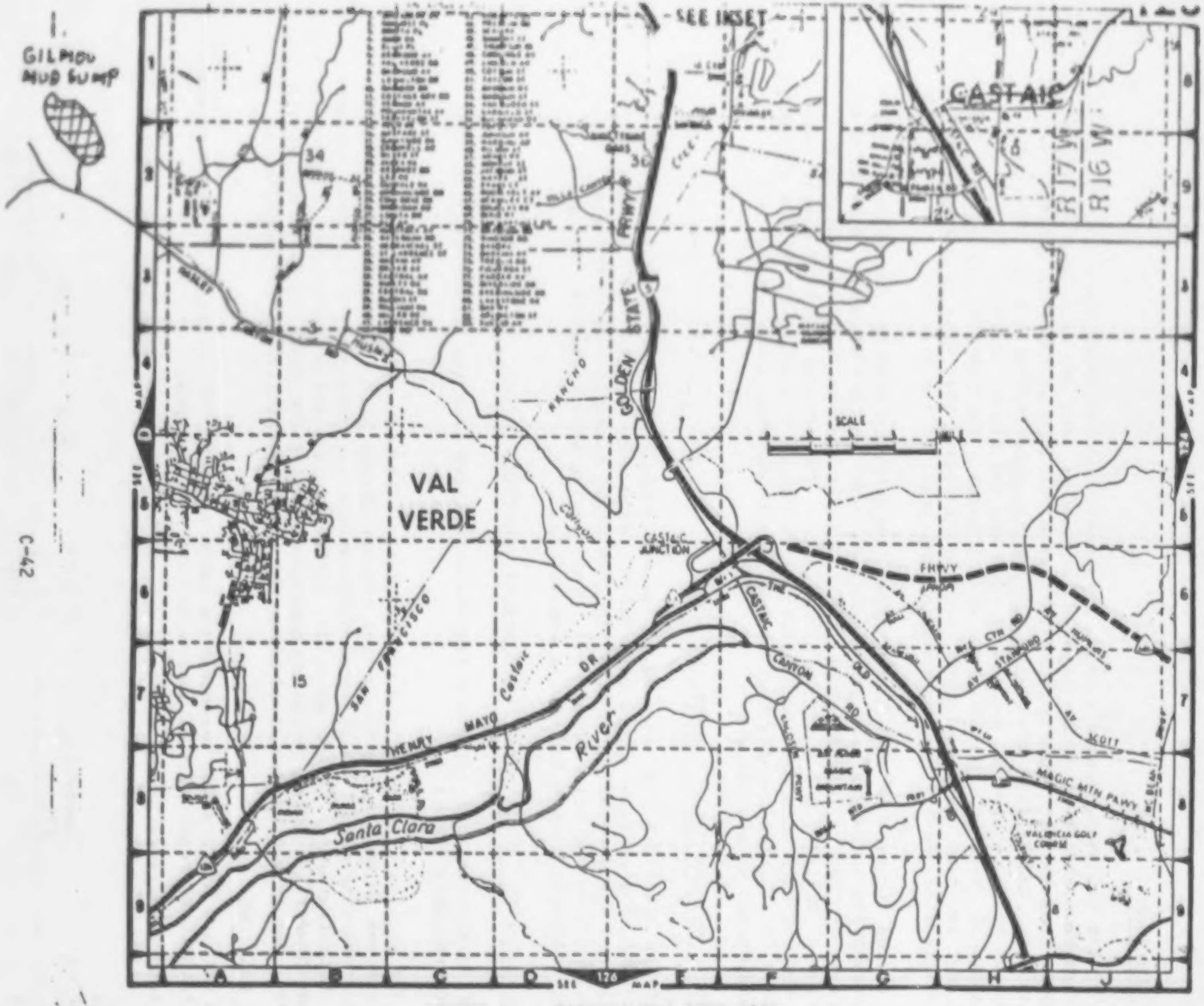

1.
GILMOU
MUD SUMP
SEE INSET
CASTAIC
R17W
R16W
VAL
VERDE
GOLDEN STATE FRWY
CASTAIC JUNCTION
RANCHO
Canyon
SAN FRANCISCO
HENRY MAYO DR
Castaic
Santa Clara
River
THE OLD CASTAIC CANYON RD
FRWY
MAGIC MTN PKWY
VALENCIA GOLF COURSE
SCOTT AV
STANFORD AV
SCALE
34
36
15
SEE 126 MAP
SEE 124 MAP
SEE D MAP
A
B
C
D
E
F
G
H
J
1
2
3
4
5
6
7
8
9

FIGURE 1. Gilmore Mud Sump Site

84-495

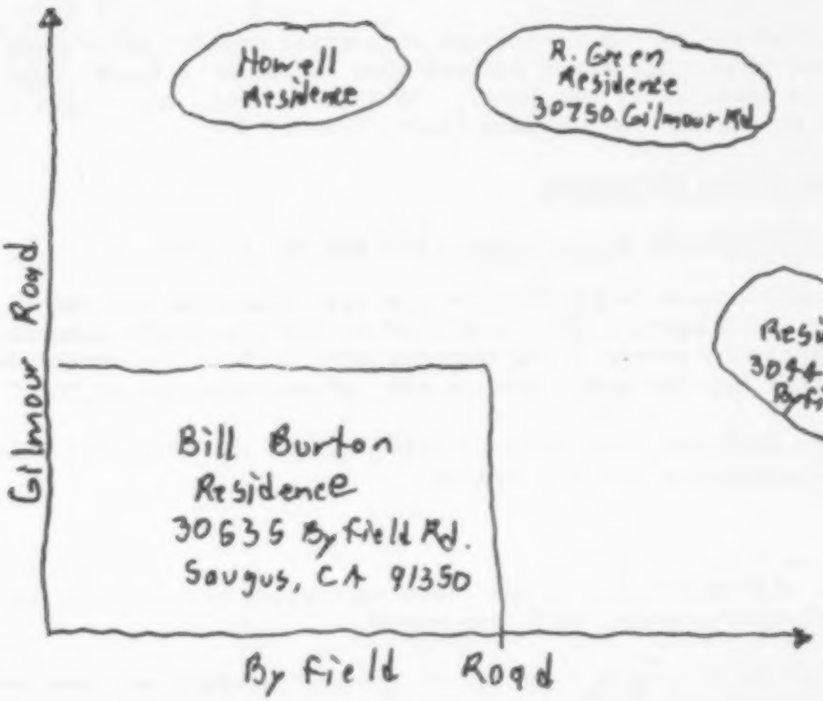

Howell Residence
R. Green Residence 30750 Gilmour Rd
Residence 30948 Byfield Rd.
Gilmour Road
Bill Burton Residence 30635 Byfield Rd. Saugus, CA 91350
Byfield Road

FIGURE 2. Residents Located on the Gilmore Mud Sump

Test No. C-84-84
Syufy

Date 2/1/84

PROCESS DESCRIPTION

Landfill gases produced by biodegradation of burried organic refuse are collected through wells and connecting pipes and are then burned by a flare. The gas collection system consists of two parts: Peripheral wells and center wells. The collected gases are burned in a common flare. See pg. #5

SAMPLING AND ANALYTICAL PROCEDURES

Vinyl Chloride, Chlorinated hydrocarbons, Benzene and Toluene

Instantaneous samples were taken from the two gas collection systems by two-liter evacuated flasks. All samples were submitted to the District's Laboratory for vinyl chloride analysis by gas chromatography with a flame ionization detector and for chlorinated hydrocarbons, benzene and toluene analysis by EC/GC and FID/GC.

Samples were also analyzed for carbon dioxide, carbon monoxide, and methane by using the total combustion analysis method.

TEST CRITIQUE

The landfill gas collection system and flare were operated normally, and the sampling and analytical results were appropriate.

Review of the results indicates that either the center wells are more efficient in collecting the gaseous constituents than the peripheral wells or that the biochemical oxidation (measured by the amount of CO_2) is greater in the center of the landfill.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

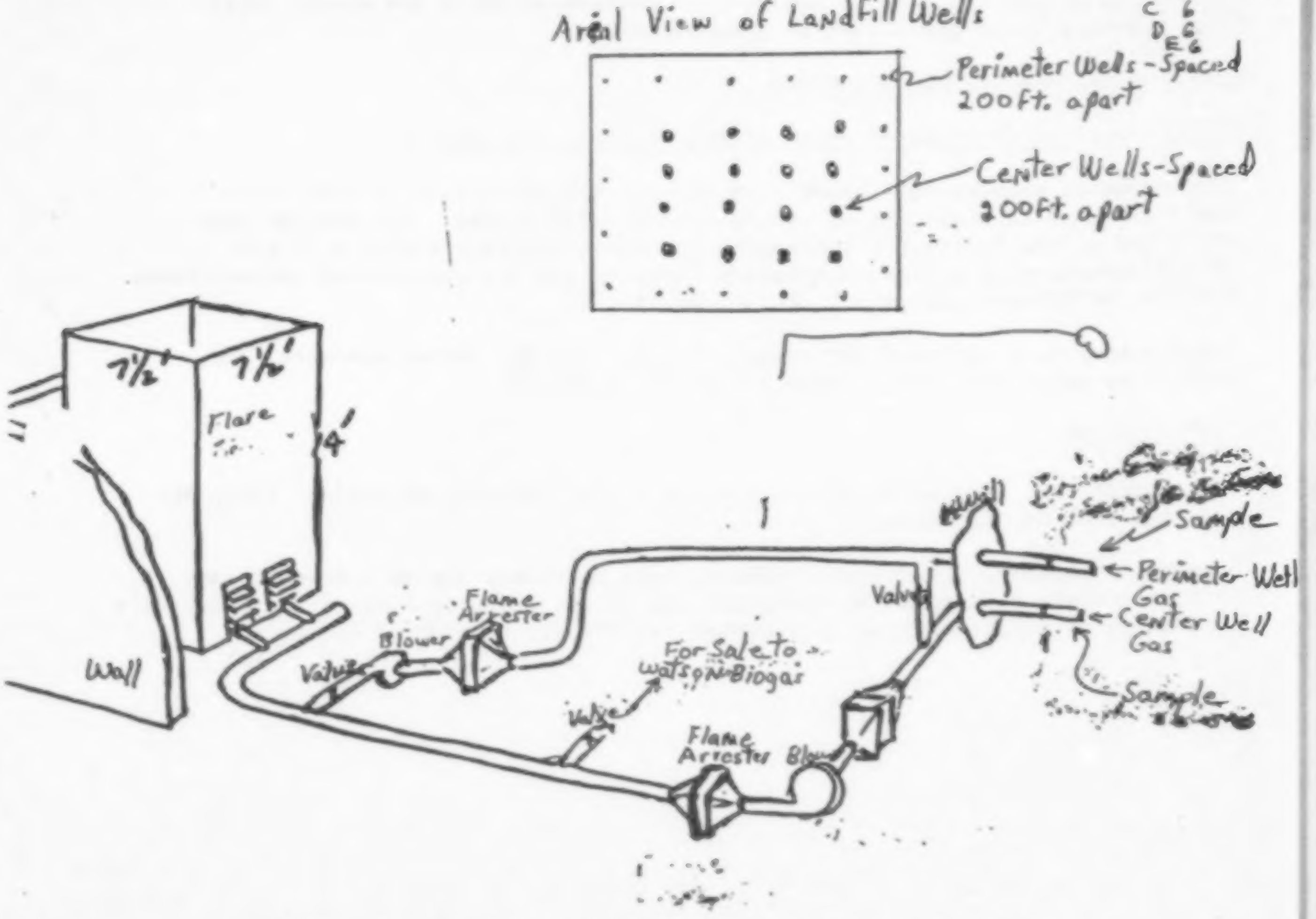
9150 Flair Drive, El Monte, California 91731

Test No. C-84-84 Date 2/1/84

Syufy

P A+G Σ 50

L A 9
B 6
C 6
D 6
E 6
F 6
G 10



Areal View of Landfill Wells
Perimeter Wells - Spaced 200 ft. apart
Center Wells - Spaced 200 ft. apart
7½'
7½'
Flare
14'
Wall
Blower
Valve
Flame Arrester
Valve
For Sale to Watson Biogas
Flame Arrester
Blower
Valve
Well
Sample
Perimeter Well Gas
Center Well Gas
Sample

SCHEMATIC OF PROCESS INDICATING SAMPLING POINTS

C-45

Page No. 5

Syufy

PROCESS DESCRIPTION

Landfill gases produced by biodegradation of buried organic refuse are collected through wells and connecting pipes and are then burned by a flare. The gas collection system consists of two parts: peripheral wells and center wells. The collected gases are burned in a common flare.

SAMPLING AND ANALYTICAL PROCEDURES

Vinyl Chloride, Chlorinated Hydrocarbons, Benzene and Toluene

Instantaneous samples were taken from the two gas collection systems and a combination of both systems by two-liter evacuated flasks. All samples were submitted to the District's Laboratory for vinyl chloride analysis by gas chromatography with a flame ionization detector and for chlorinated hydrocarbons, benzene and toluene analysis by EC/GC and FID/GC.

Samples were also analyzed for oxygen, carbon dioxide, carbon monoxide, and methane by using the total combustion analysis method.

TEST CRITIQUE

The landfill gas collection system and flare were operated normally. Equipment operated with no malfunctions.

However, chlorinated hydrocarbon results were extremely low in concentration; this was caused by sample deterioration due to the heavy backlog in the District's Laboratory. The chlorinated hydrocarbon results are considered erroneous.

LANDFILL DESCRIPTION

The Kalico #2 landfill is a Class II inactive landfill that was closed in 1962. There is no gas collection system for either the perimeter or interior of the landfill. It is surrounded by industrial and open storage facilities. The surface is flat with a crushed rock hard covering. The land is now owned by Central Industrial Engineering, Co., Inc. and is used for open storage of structural steel.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill and its outer boundary. The OVA measured values and site locations are shown in the field surface survey sheet (see pg. # 4) and in FIGURE I, respectively. Also, the bucket collection method (see FIGURE II)was used at 4 locations that gave the highest readings on the OVA.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

No problems were encountered during sampling. Five hot spots (high readings on the OVA) were found during sampling at sites A, C, E, F and G. The bucket at site F was placed over a crack. No landfill odors were detected except at site E and F.

Test No. 84-503 Date 10/18/84

Kalico #2

SURVEY LOCATIONS

(A) Bucket #1 > 10,000 ppm ~ 30' long crack - 2:04 p.m. - runs parallel to fence and 4' north of fence - sampled with bulb RY @ 2:36.

(B) 2000 ppm

(C) > 10,000 ppm ~ 20' long crack under steel < S

(D) 1000 ppm crack in dirt - crack in blacktop 0 ppm

(E) > 10,000 ppm ~ 20' N-S crack under steel

(F) > 10,000 ppm bucket #2 @ 2:42 - crack ~ 150' N-S and varied 500 to 10,000 ppm

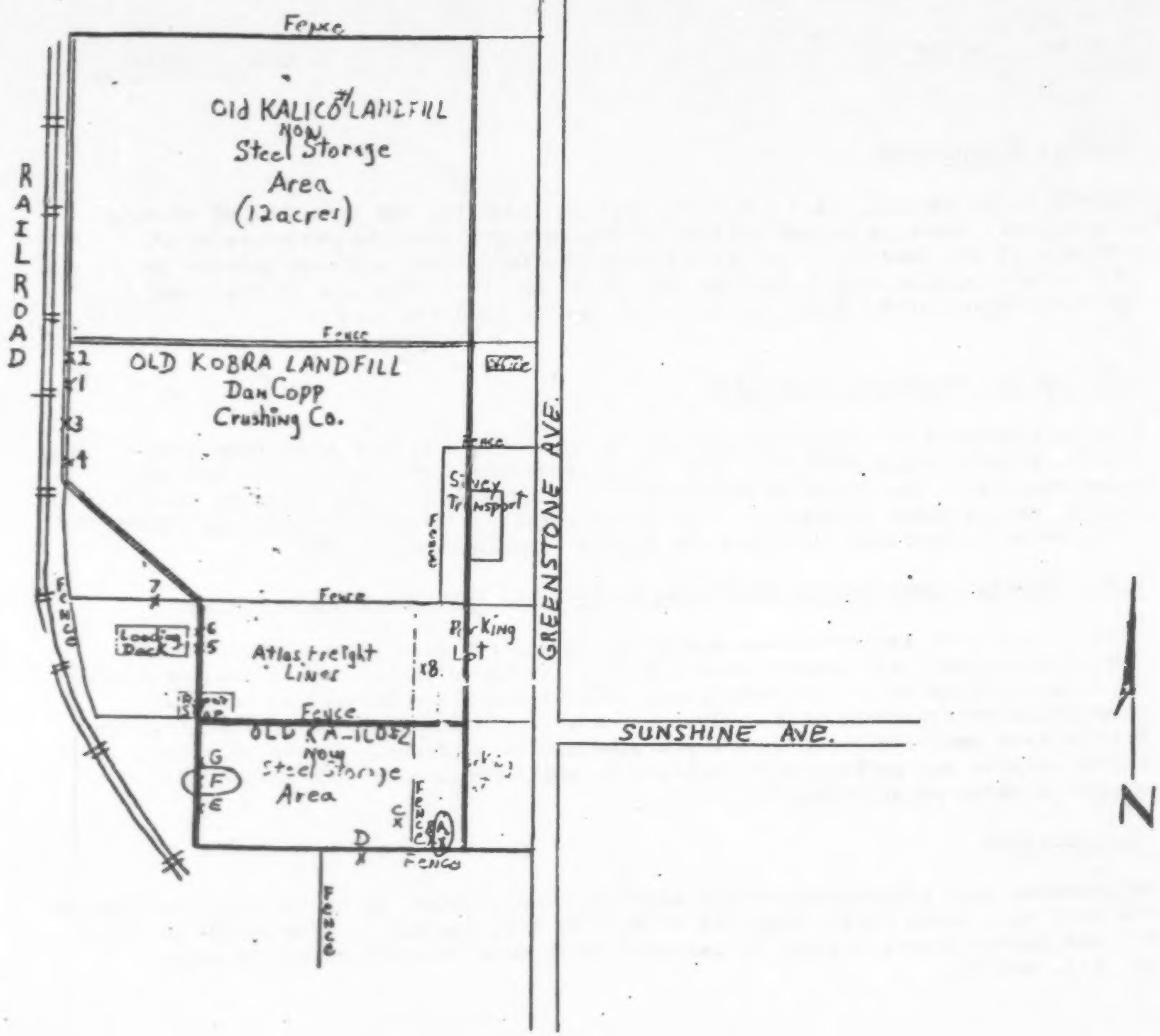
Bulb T.D. @ 3:10

Note suspect this crack is same one running N-S across Atlas Frt. Line Co.

located 20' E of loading back

(G) > 10,000 ppm

port # 84-503 Test Date 10/1[illegible]/[illegible]


Fence
Old KALICO #1 LANDFILL
NOW
Steel Storage
Area
(12acres)
RAILROAD
Fence
OLD KOBRA LANDFILL
Dan Copp
Crushing Co.
Office
X2
X1
X3
X4
Fence
Silvey
Transport
Fence
GREENSTONE AVE.
7
X
Fence
FENCE
Loading Dock
X6
X5
Atlas Freight
Lines
X8.
Parking
Lot
Fence
OLD KALICO #2
NOW
Steel Storage
Area
G
F
E
C
X
FENCE
A
X
D
X
Fence
Fence
Parking
SUNSHINE AVE.
N

X Denotes sampling location using Century OVA

(See Attached Sheet for CH_4 Values and Bucket Placement)

NOTE: Double line indicates boundary of landfill

FIGURE I

LANDFILL SCHEMATIC
OF KALICO NOS. 1 & 2 C-49
and KOBRA

LANDFILL DESCRIPTION

The Kalico #1 landfill is a Class II inactive landfill, and it's date of closing is unknown. There is no gas collection system for either the perimeter or the interior of the landfill. It is surrounded by industrial and open storage facilities. The surface is flat with a crushed rock hard covering. The land is now owned by Central Industrial Engineering, Co., Inc. and is used for open storage of structural steel.

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century Organic Vapor Analyzer (OVA) along the surface of the landfill and its outer boundary. The OVA measured values and site locations are shown in the field surface survey sheet (FIGURE I). Also, the bucket collection method (see FIGURE II) was used at 4 locations that gave the highest readings on the OVA.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 and O_2

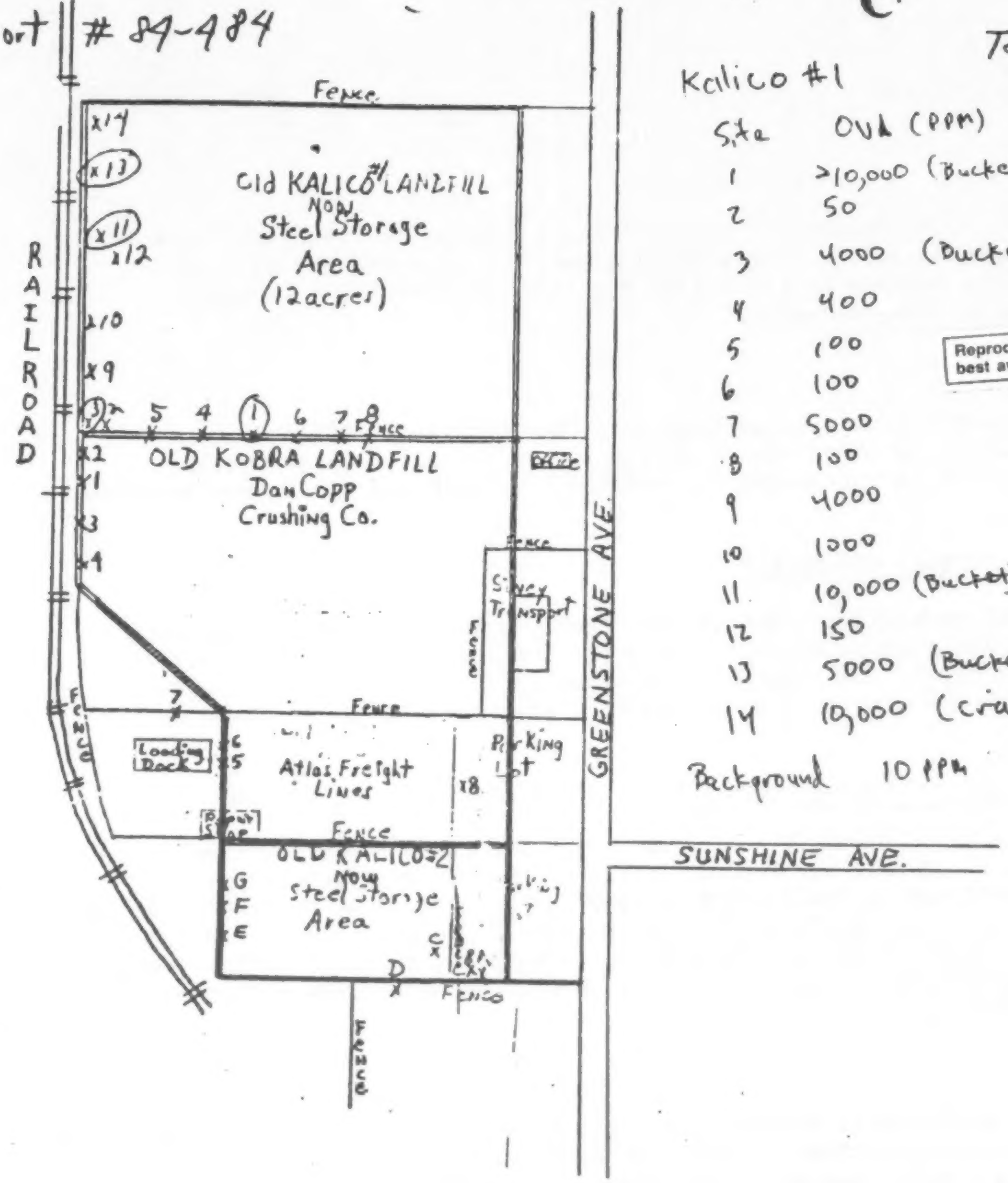
After 2 hours, an instantaneous sample was taken from each bucket by two-liter vacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

No problems were encountered during smapling. Only three hot spots (high readings on the OVA) were found during sampling at Site #1, #11, and #14. The bucket at site #11 was placed over a crack. No landfill odors were detected except at sites #1, #11, and #14.

port # 84-484

Test Date 9/28/84


Fence
x14
x13
x11
x12
x10
x9
Old KALICO #1 LANDFILL
NOW
Steel Storage
Area
(12acres)
RAILROAD
3 x 2 5 4 1 6 7 8
Fence
OLD KOBRA LANDFILL
Dan Copp
Crushing Co.
x2
x1
x3
x4
Fence
Sincy
Transport
Fence
7
Fence
Loading Dock
6
5
Atlas Freight
Lines
x8
Parking
Lot
Fence
OLD KALICO #2
NOW
Steel Storage
Area
G
F
E
C
D
Fence
Fence
GREENSTONE AVE.
SUNSHINE AVE.
N

Kalico #1

Site	OVA (PPM)
1	>10,000 (Bucket)
2	50
3	4000 (Bucket)
4	400
5	100
6	100
7	5000
8	100
9	4000
10	1000
11	10,000 (Bucket)
12	150
13	5000 (Bucket)
14	10,000 (crack)

Background 10 PPM

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X — Denotes sampling location using Century OVA

NOTE: Double line indicates boundary of landfill

FIGURE I

LANDFILL SCHEMATIC
OF KALICO NOS. 1 & 2
AND KOBRA

[illegible]
50 Flair Drive, El Monte, California 917

Test No. 84-464

Date 9/14/84

INTRODUCTION

On September 14, 1984, Messrs. S. Marinoff and P. Chavez of the South Coast Air Quality Management District, Source Testing Section, surveyed the gaseous emissions from the surface of the Russel Moe Landfill (Old Lopez Canyon), 12089 Lopez Canyon, San Fernando.

LANDFILL DESCRIPTION

The Russel Moe Landfill (Old Lopez Canyon) is an inactive landfill which was closed approximately in 1956. Its top lift is covered with approximately 35 feet of soil. It is surrounded by a mobile home park and small manufacturing. (See Figure 1)

SAMPLING AND ANALYTICAL PROCEDURES

Testing consisted of measuring the gaseous total hydrocarbons as methane with a Century organic Vapor analyzer (OVA) along the surface of the landfill and its outer boundary. Values and locations are shown in Figure 1. Also, the bucket collection method was used at 2 locations that gave the highest readings on the OVA.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 2 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

No problems were encountered during sampling. Only two hot spots were found during sampling. Both were approximately 100 feet apart with numerous cracks. Bucket #1 was placed over a crack. Bucket #2 was placed upon sandy soil.

84464

9/14/84

RUSSEL MOE LANDFILL

(Methane Samplings in ppm

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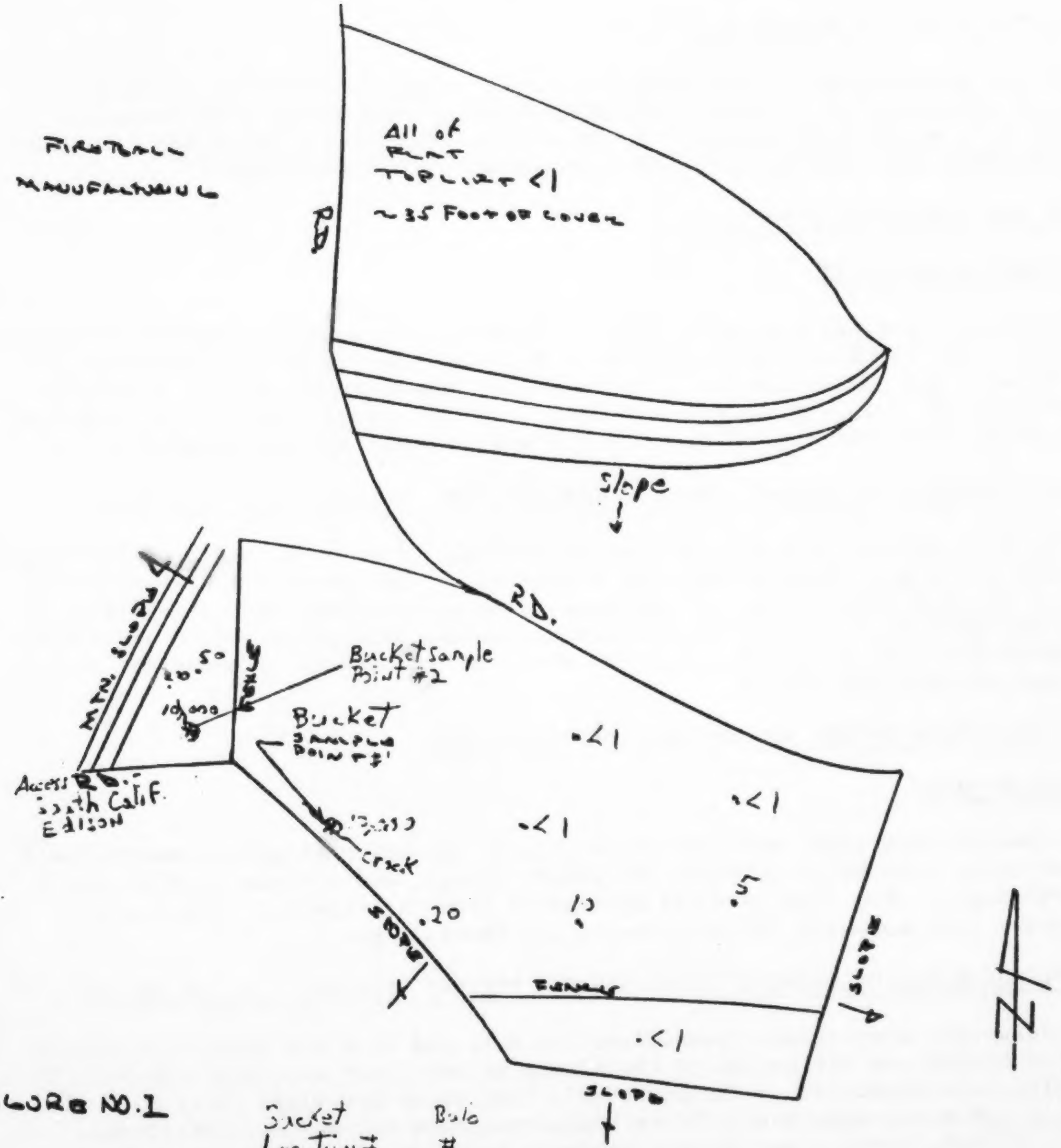

FIREBALL
MANUFACTURING
RD
All of
FLAT
TOP LIFT <1
~35 FOOT OF COVER
Slope
RD.
MTN. SLOPE
50
20.
10,000
FENCE
Bucket Sample
Point #2
Bucket
SAMPLE
POINT #1
Access RD.
South Calif.
Edison
13,000
Creek
.<1
.<1
.<1
10
.5
.20
SLOPE
FENCE
SLOPE
.<1
SLOPE
N

FIGURE NO.1

Socket Location #	Bulb #
1	14C
2	P37

INTRODUCTION

The Davis landfill has been inactive for approximately the past 20 years and contains about 700,000 cu. yds. of waste. These wastes may contain some Group I (drilling muds). The landfill is bordered by a new housing project, existing residential homes, and vacant land. Part of the landfill surface is now occupied by a mobile home park. (See FIGURE I)

GAS COLLECTION SYSTEM DESCRIPTION

Landfill gas produced by biodegradation of buried organic refuse and chemical wastes are collected by 11 Wells manifolded together to a blower that vents to a 35 feet tall stack (not flared). There are also other Wells along the perimeter of the landfill that vent naturally to the atmosphere. (See FIGURE I)

SAMPLING AND ANALYTICAL PROCEDURES

I. LANDFILL SURFACE GAS

Landfill surface gas was collected at 3 locations by using the bucket collection method. See FIGURE #1 for locations of buckets. Bucket #1 was placed on unoccupied land on the landfill, bucket #2 was placed on the mobile home park property, and bucket #3 was placed on unoccupied land adjacent to the landfill boundary. The land with #3 bucket on it was formally another landfill.

VINYL CHLORIDE CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

After 24 hours, an instantaneous sample was taken from each bucket by two-liter evacuated flasks. All samples were submitted to the District's Laboratory for vinyl chloride analysis by gas chromatography with a flame ionization detector and for chlorinated hydrocarbon, benzene, toluene analysis by EC/GC and FID/GC. Samples were also analyzed for carbon monoxide and methane by using the total combustion analysis method.

II. GAS COLLECTION SYSTEM AND ONE GAS COLLECTION WELL

GAS FLOW RATE

The landfill gas inlet velocity to the blower was measured with a conventional Pitot tube, Magnehelic differential pressure gage, and a Minimite with type-K thermocouple. The flow rate was determined from the velocity, temperature, pressure, and assuming 10% moisture in the landfill gas.

VINYL CHLORIDE, CHLORINATED HYDROCARBONS, BENZENE, TOLUENE, CO, CO_2 AND O_2

Instantaneous samples were taken from the Well and from the landfill gas inlet to the blower and the outlet of the blower by two-liter evacuated flasks. All samples were submitted to the District's Laboratory for vinyl chloride analysis by gas chromatography with a flame ionization detector and for chlorinated hydrocarbons, benzene and toluene analysis by EC/GC and FID/GC.

Test No. 84-277 Date 5/16/84

DAVIS

Samples were also analyzed for carbon monoxide and methane by using the total combustion analysis method.

TEST CRITIQUE

The landfill gas collection system was operating normally. The low value of methane measured from the outlet of the blower varifies that it is too low to support combustion. Both the landfill gas blower inlet and outlet were measured to determine any dilution air from the blower. The results showed negligable air leakage, and therefore, the inlet flow rate can be assumed to equal the outlet flow rate.

The Well sampled was located near the existing residential homes. This Well is one of the 11 Wells connected to the gas collection system.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive, El Monte, California 91731

No. C-84-277 Date 5/16/84

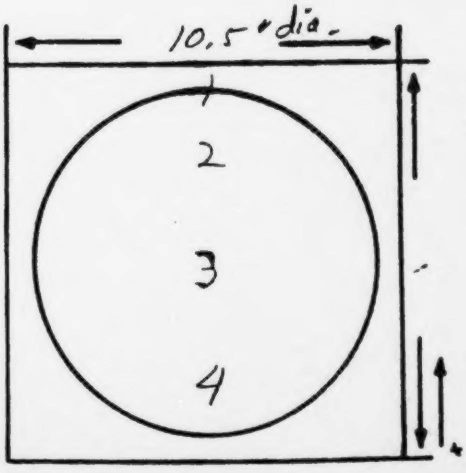
Sampling Location DAVIS Landfill Gas Inlet to Blower

Gas Velocity Data

Point	Vel. Head In. H_2O	Temp. °F	Velocity Ft./Sec.	Vel. Head In. H_2O	Temp. °F	Velocity Ft./Sec.	Vel. Head In. H_2O	Temp. °F	Velocity Ft/Sec.
1	.21	95	31.3						
2	.25	↓	34.2						
3	.25		34.2						
4	.21		31.3						
	Avg. Vel. = 32.8								

Static Pressure in Stack (P_S), In. Hg A 29.9 Conducted by SM, PC

A. Average Velocity (Traverse) .... 32.8 ft/sec
B. Average Velocity (Reference Pt.) .... ft/sec
C. Flue Factor A/B ....
D. Velocity Pressure Correction Factor ... $\sqrt{\frac{29.92}{P_S}}$ 1.00
E. Pitot Correction Factor 1.00
F. Gas Density Correction Factor .... 1.00 (Assumed)
G. Corrected Velocity, A x D x E x F .... 32.8 ft/sec
or B x C x D x E x F .... ft/sec
H. Area of Flue .... 0.601 ft^2
I. Average Flue Temperature .... 95 °F
J. Flow Rate, H x G x 60 .... 1180 cfm
Flow Rate, $\frac{P_S}{29.92} \times \frac{520}{(I + 460)} \times J$ .... 1,110 scfm
L. Percent Water Vapor in Gas Sample .... 10 (Assumed) %
M. Dry Gas Flow Rate, $K(1 - \frac{L}{100})$ .... 1,000 dscfm



Stack Layout

C-56

Test No 85-1 Date 1/10/85

INTRODUCTION

The Davis Landfill has been inactive for approximately the past 20 years and contains about 700,000 cubic yards of Class II wastes. These wastes may contain some classified as Group I (drilling muds). The landfill is bordered by a new housing project, existing residential homes, and vacant land. Part of the landfill surface is now occupied by a mobile home park (FIGURE NO. 1).

GAS COLLECTION SYSTEM DESCRIPTION

Landfill gas produced by biodegradation of buried organic refuse and chemical wastes are collected by 11 wells manifolded together to a blower that vents to a 35 foot tall stack. There are also other wells along the perimeter of the landfill that vent naturally to the atmosphere.

SAMPLING AND ANALYTICAL PROCEDURES

I. LANDFILL SURFACE GAS

Landfill surface gas was collected at 1 location by using the bucket collection method. See FIGURE 1 for location of bucket. The bucket was placed on unoccupied land on the landfill.

Vinyl Chloride Chlorinated Hydrocarbons, Benzene, Toluene, CO, CO_2 & O_2

After 2 hours, an instantaneous sample was taken from the bucket by a two-liter evacuated flask. The sample was submitted to the District's Laboratory for vinyl chloride analysis by gas chromatography with a flame ionization detector and for chlorinated hydrocarbon, benzene, toluene analysis by EC/GC and FID/GC. The sample was also analyzed for carbon monoxide and methane by using the total combustion analysis method.

II. GAS COLLECTION SYSTEM AND ONE GAS COLLECTION WELL

Vinyl Chloride, Chlorinated Hydrocarbons, Benzene, Toluene, CO, CO_2 & O_2

Instantaneous samples were taken from the well and from the landfill gas inlet to the blower and the outlet of the blower by two-liter evacuated flasks. All samples were submitted to the District's Laboratory for vinyl chloride and analysis of gas chromatography with a flame ionization detector and for chlorinated hydrocarbons, benzene and toluene analysis by EC/GC and FID/GC. Samples were also analyzed for carbon monoxide and methane by using the total combustion analysis method.

TEST CRITIQUE

The landfill gas collection system was operating normally. The low value of methane measured at the outlet of the blower verifies that it is too low to support combustion. Both the landfill gas blower inlet and outlet were measured to determine any dilution air from the blower. The results showed negligible air leakage. One sample bulb for the blower inlet showed a low oxygen value and no methane. This bulb's results were considered erroneous.

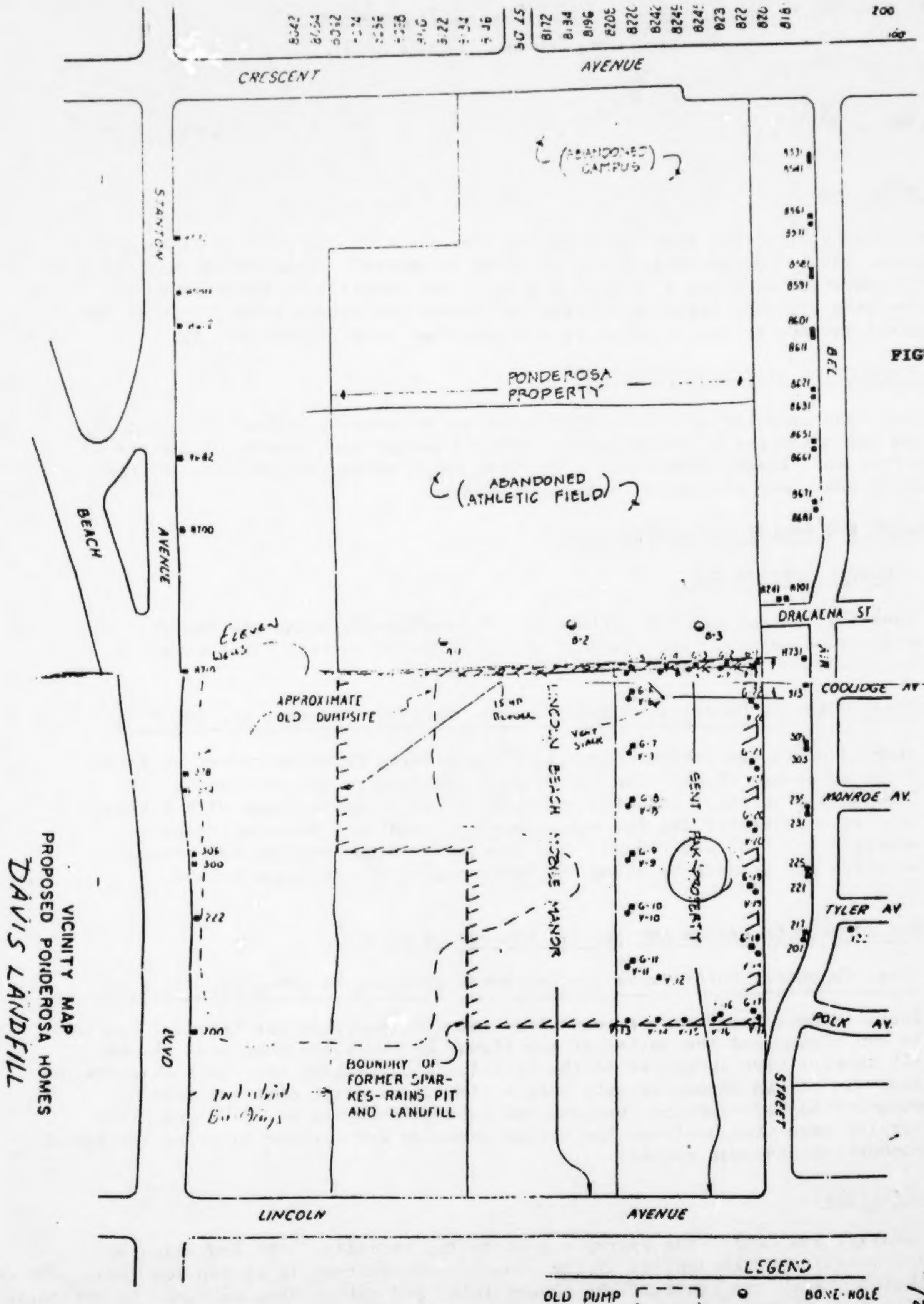

VICINITY MAP
PROPOSED PONDEROSA HOMES
DAVIS LANDFILL
CRESCENT AVENUE
STANTON AVENUE
BEACH BLVD
LINCOLN AVENUE
BEL AIR STREET
DRACAENA ST
COOLIDGE AV
MONROE AV
TYLER AV
POLK AV
(ABANDONED CAMPUS)
PONDEROSA PROPERTY
(ABANDONED ATHLETIC FIELD)
Eleven Lights
APPROXIMATE OLD DUMPSITE
15 HP Blower
VENT STACK
LINCOLN BEACH MOBILE MANOR
SENT - FAN - PROPERTY
BOUNDARY OF FORMER SPARKES-RAINS PIT AND LANDFILL
Inhabited Buildings
B-1
B-2
B-3
200
100
LEGEND
OLD DUMP
LANDFILL
BORE-HOLE
VENT-STACK
G-CHR GAS METER BOX
7/21

FIGURE I

INTRODUCTION

On April 18, 1985, Messrs. S. Marinoff, and D. Carrillo of the South Coast Air Quality Management District, Source Testing and Monitoring section, performed a landfill emission survey at Adams Ind., 2111 Dolores Street, Carson, California.

The landfill is inactive with no gas migration system installed, onto which a Mobile Home Park (Imperial Carson Mobile Estates) is built. (see FIGURE I).

SAMPLING AND ANALYTICAL PROCEDURES

Sampling was accomplished incorporating the use of an Organic Vapor Analyzer (OVA) utilizing the Random Walk Method, which consists of locating hot spots (highest hydrocarbon readings, as methane). Once the hot spots are located, inverted buckets are placed over the spots and gases collected in the buckets are allowed to stablize for several hours. Then a gas sample is taken from each bucket by a 2-liter glass bulb. (see FIGURE II).

All samples were submitted to the District Laboratory for vinyl chloride analysis by gas chromatography (GC) with a flame ionization detector. Chlorinated hydrocarbons were analyzed by Electron Capture with a GC. Benzene and toluene were analyzed by GC with a photoionization detector. Carbon monoxide, carbon dioxide and methane were analyzed by NDIR/GC using the TCA method and oxygen is obtained by GC/TC.

TEST CRITIQUE

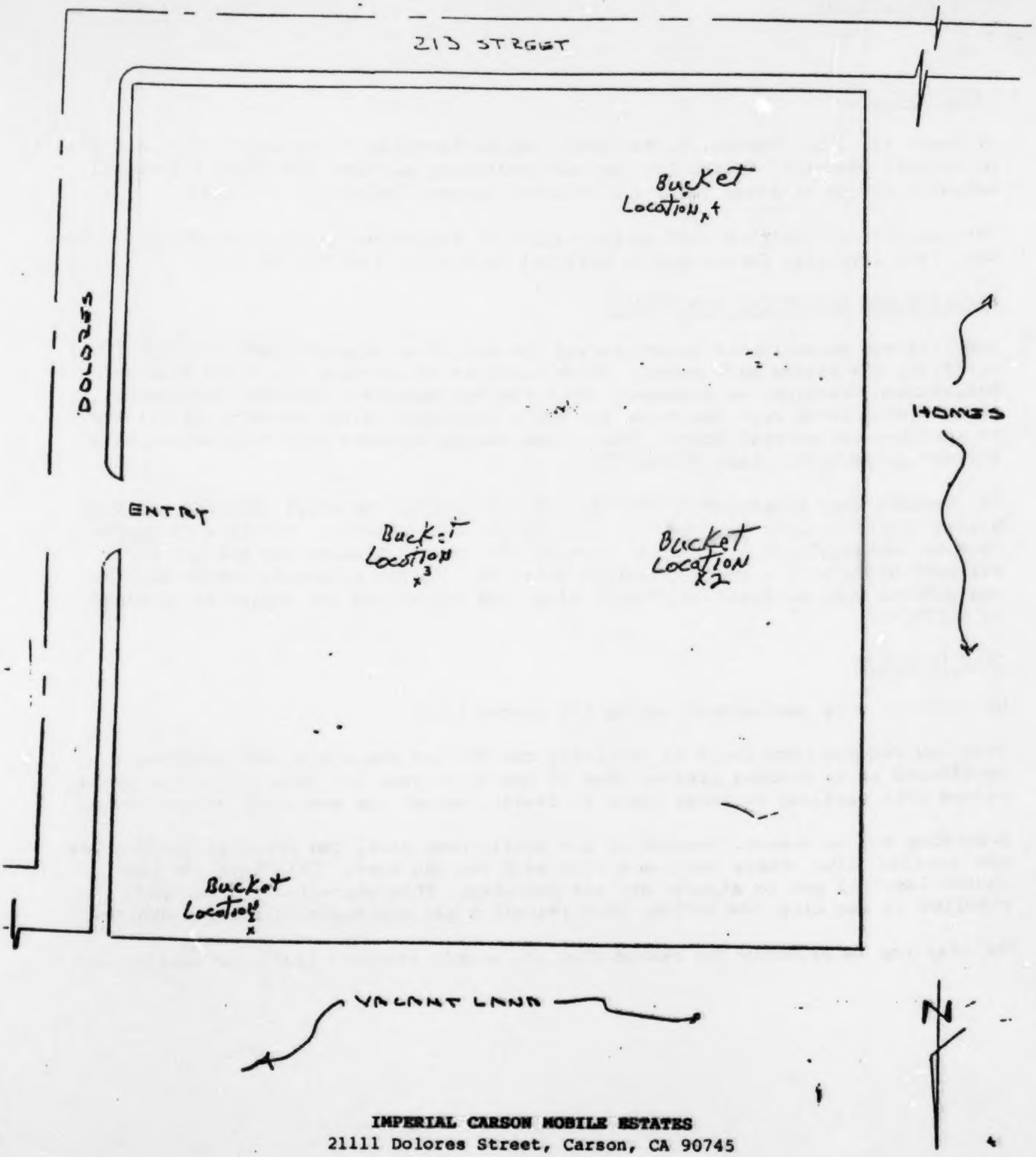
No problems were encountered during the source test.

Very low reading were found by utilizing the OVA and therefore, hot spots were considered to be reading greater than 10 ppm as methane for this test. Hot spots values were similiar to those found in 84-435, except one new location was found.

According to the Assist. Manager of the mobile home park, the landfill surface was not settled like others because a clay soil top was used. This hard top has caused landfill gas to migrate off the property. This migration problem has resulted in the city now making them install a gas migration collection system.

The clay top is probably the reason that the sample analysis indicated ambient air.

84-435 'Adams Aug 15, 19[illegible]

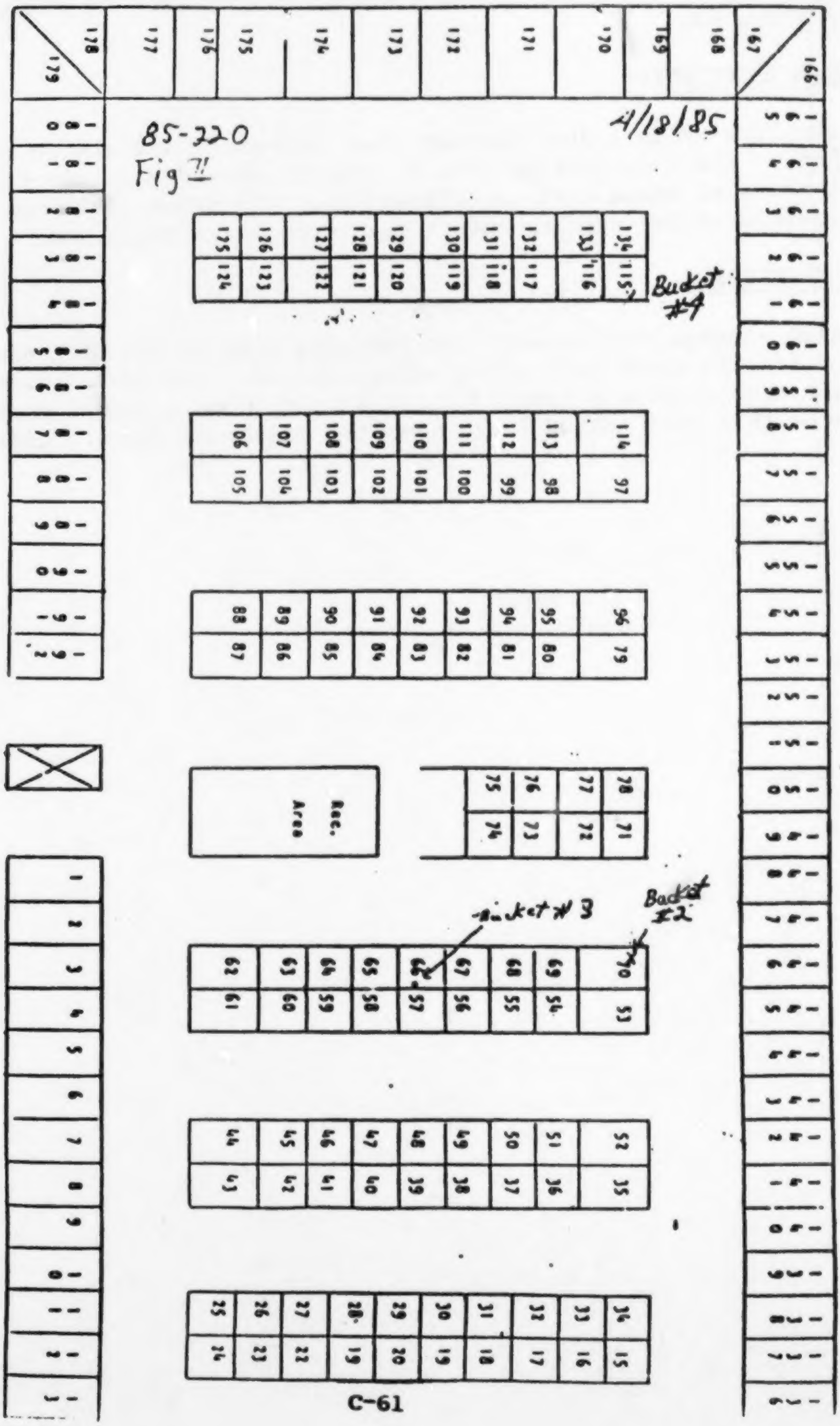

213 STREET
DOLORES
Bucket Location x4
HOMES
ENTRY
Bucket Location x3
Bucket Location x2
Bucket Location x
VACANT LAND
N

IMPERIAL CARSON MOBILE ESTATES
21111 Dolores Street, Carson, CA 90745

MOBILEHOME PARK
Plot Plan
C-60

- NO. I

84-435 Adams


85-220
Fig 7
4/18/85
Bucket #4
Bucket #3
Bucket #2
Rec. Area

IMPERIAL CARSON MOBILE ESTATES
2111 Dolores Street, Carson, CA 90745

cKet#	Bulb#
1	TA
2	FS
	8N
	BG

INTRODUCTION

On October 4, 1984, Messrs. S. Marinoff, P. Chavez, conducted a landfill emissions survey at Velle Circuits formally Metropolitian Circuits located at 1216 Logan Ave. Costa Mesa, CA.

PROCESS DESCRIPTION

The area tested is a drum storage shed located behind and on the west side of the facility. The drum storage area is mostly covered with concrete and asphalt with small areas of loose dirt (see FIGURE I). The drums (full and empty) contain chemicals used for etching and other circuit board processes.

TEST CRITIQUE

The drum storage surface area was surveyed with an OVA (Organic Vapor Analyzer) and no organic gases were found being emitted. The OVA is capable of measuring organic concentrations down to a concentration of 1 ppm as carbon. The site is the same that DOHS tested (soil samples) and found them to contain heavy metals.

84-493

VELLE CIRCUITS
Plot Plan

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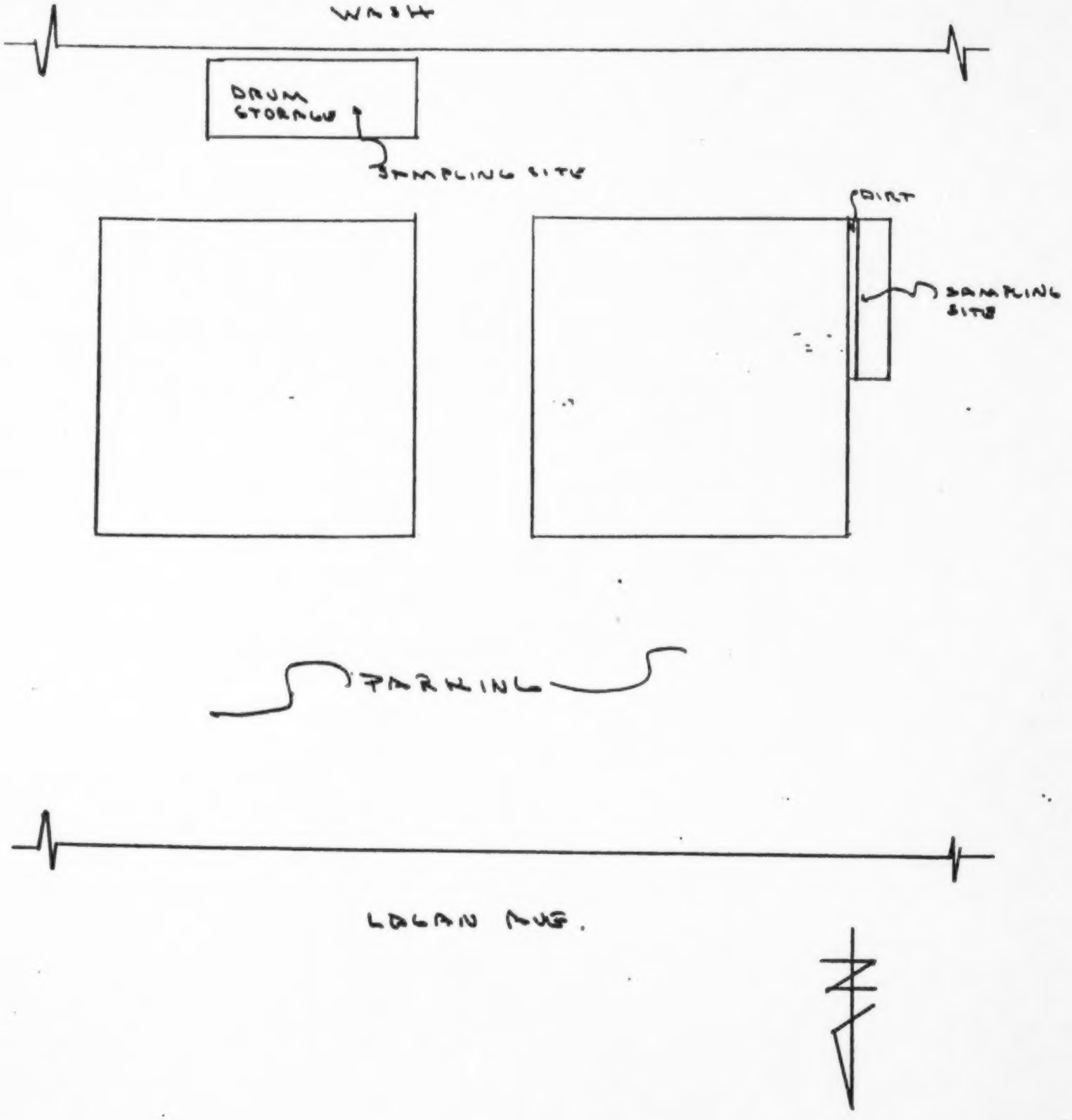
WASH
DRUM STORAGE
SAMPLING SITE
DIRT
SAMPLING SITE
PARKING
LOGAN AVE.
N

FIGURE I